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Screeding and Rolling Sand Cushion; Laying Brick; Batting in Along the Car Track Area and Around Castings

RESURFACING 82 FT. STREET AT RICHMOND, VA., WITH VITRIFIED BRICK

By A. MASON HARRIS
Chief of the Bureau of Streets

A 3 IN. vitrified brick pavement was recently constructed on Broad St. from Third St. to Ninth St., replacing a 4 in. asphalt block pavement which was constructed in 1913. The asphalt blocks had worn very unevenly under traffic, and they also had been softened by oil and gasoline drippings from automobiles parked along the curbs, forming depressions which created a bad drainage condition.

General Conditions.—Broad St. is the center of the retail business district. It is 82 feet between curbs with a double car track in the center and sidewalks 18 ft. wide. A traffic count taken recently for the twelve hours from 7:00 a. m. to 7:00 p. m. was approximately 14,700 vehicles.

The granite curbs were probably constructed some 50 or 60 years ago and had at the corners 3 ft. radius blocks with deep impressions for the basin inlets. The contract for resurfacing this street with vitrified brick included the replacement of these 3 ft. corner blocks with 18 ft. radius granite curb with 8 ft. slit opening inlets constructed of concrete at each end of the return.

Preliminary Work.—As soon as the old asphalt block and sand cushion were removed, the 6 in. concrete base was thoroughly broomed for inspection. It was found to be in very good condition; however, the original construction had been rough and uneven and there had also been numerous utility patchings since its original construction.

Before actual paving operations could be started, the electric railway company had to renew its ties and rails through the entire length of the project. Also the public utilities department renewed its gas and water connections for each piece of property. Both of these operations were carried on night and day, and in fact all operations on this project were worked 24 hours a day with the exception of the actual laying of the bricks.

Dropping Brick and Lining Every Fourth Row by Knocking Back

The electric railway company strung incandescent lights from its poles along the center of the street and these with the ornamental lighting system on the sidewalks gave enough light for all of the night work.

The grade of the railway track was lowered approximately 1 in. to take up the difference between the 4 in. asphalt block and the 3 in. vitrified brick used. The grade of the new pavement was established to fit the old base as near as practicable at 50 and 100 ft. intervals by placing a brick at the desired grade on a mortar bed at the gutter, 10, 20 and 30 ft. from the gutter. Intermediate grade points were then put in by sighting across the top of the bricks set as grade points.

Preparation of Base.—When the new grade for a block had been established the utility castings were then broken out of the base and reset in concrete to the new grade. The base was then thoroughly washed and a leveling course used over the old base to bring it to a uniform smooth surface. Where the base had to be brought up 1 in. or less, sand mortar was used in the proportion of 7 sacks of cement per cubic yard; where the depth was greater than 1 in., concrete made of ¾ in. gravel and 4 sacks of cement per cubic yard were used. Although the old base was very rough and uneven the cost of the leveling course only averaged $0.155 per square yard.

The Sand Bed.—The sand bed was spread the day after the base was brought to grade with the leveling course. Screed boards ⅝ in. thick and 4 in. to 6 in. wide were placed at right angles to the curb and about 10 ft. apart. The screed boards were brought to grade by forcing enough sand under them so that a brick placed on the board in line with an established grade brick would touch the string line. Original grade points were not removed until the screed boards were set. The sand was then struck off by working a 4 in. by 4 in. by 12 ft. straight edge on the screed boards. After the sand bed was struck off it was then rolled and straight edged again to fill any depressions that were left by the roller. The screed boards were then removed and the depressions formed by them were filled with sand which was tamped with a 12 in. by 12 in. steel tamp and smoothed off by the most expert of the sand bed men. The compacted sand bed averaged approximately ¾ in. in depth. The roller used for rolling the sand bed was 30 in. long and 36 in. in diameter, filled with water to weigh 12 lb. per inch of length, and it was provided with a 12 ft. handle.

Laying the Brick.—The bricks used on this project were 3 in. vertical fibre with side lugs. They were brought to Richmond in barges, stored on the adjacent sidewalk and carried from there to the droppers on pallets holding 9 bricks each. The droppers laid four rows at a time and were followed by men lining the brick, using in some instances a 6-lb. sledge hammer striking against a 3 in. by 3 in. by 3 ft. timber and again, when necessary, opening the joints slightly with a light crow bar.

Grade Points Set Ahead of Concrete Leveling Course; Resetting Castings to Grade

A light buff brick was used for pedestrian traffic markers at street intersections. As these markers had to be exactly straight, they were lined with a transit and the use of these markers also called for extreme care in the lining of the brick pavement. Seventy courses were marked off before reaching the traffic line markers and any error in the lining of the courses were corrected before reaching the markers.

The grades on this street varied from 0.15 per cent to 0.50 per cent. It can be seen that a variation of ¼ in. under a 10 ft. straight edge would pond water for over 13 ft. in the gutter on a 0.15 per cent. To prevent water standing in the gutter, the bricks were checked after rolling with a 16-ft. straight edge and any irregularities found were corrected. Rolling was followed by culling and checking the surface. Slightly high spots were rolled down. Low areas had to be relaid with sand added to the cushion.

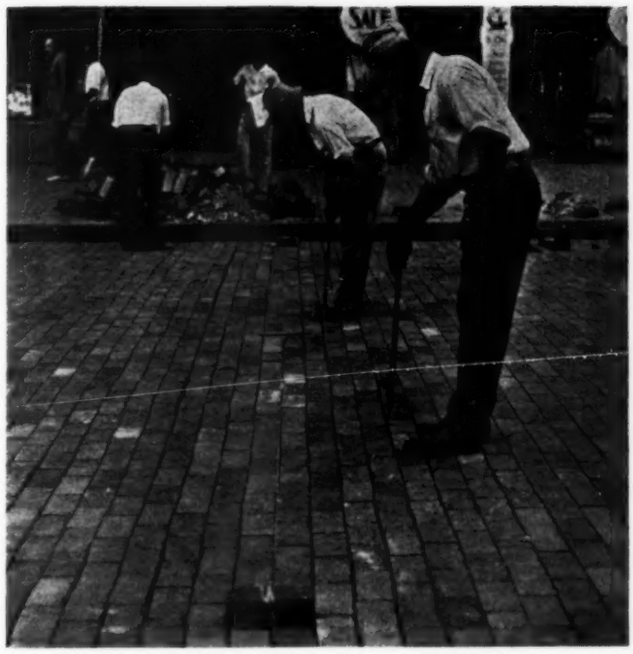
Removing Excess Asphalt Filler.—The contract for the first brick paving with asphalt filler removed from the surface, in Richmond, was let June, 1932. A thick whitewash applied with 3 in. paint brushes was used as the separating agent. This method was again used in 1933 and also on this project. Thick whitewash will not run down the sides of the bricks unless applied greatly in excess of the amount required. The excess asphalt on the surface of the brick was removed with flat garden spades.

The asphalt joint filler used was the tentative specification of the A. M. E. and tested as follows:

Penetration at 77°	32
Melting Point	165°F.
Flash Point	470°F.
Ductility	5 c.m.s.

The filler was heated to from 400°F. to 425°F., although it was found that during the very hot weather that this work was in progress a temperature of 360°F. gave satisfactory results.

The chief objection to using whitewash on the bricks is that the lime carried back to the kettles with the asphalt removed from the surface settles at the bottom of the kettles and makes it slow to heat. The kettles on this work were cleaned every day.



Work was pushed as much as possible but was confined to one side of two city blocks at one time. The old asphalt block and sand bed were removed at night. The leveling course was poured and the bricks laid, rolled and inspected in daylight. The joint filler was applied at night.

The resulting pavement when tested with a 16 ft. straight edge showed variations less than ⅜ in. and less than ¼ in. under a 10 ft. straight edge.

The contract price for furnishing and laying brick paving on this project, including of course the asphalt filler and its removal, was $2.12 per square yard. The total cost per square yard, which included the removal of the old asphalt blocks, sand bedding and constructing the leveling course, etc., was $2.72.

Col. R. Keith Compton is Director of Public Works of the City of Richmond and the writer is Chief of the Bureau of Streets.

Pouring Asphalt Joint Filler from Wheelbarrows and Removing Excess Asphalt from Surface of Pavement

Improved Liquid Tar Penetration Macadam, Monroe County, New York.

MODERN CONSTRUCTION METHODS FOR TAR MACADAM

By GEO. E. MARTIN
Consulting Engineer, General Tarvia Department, The Barrett Co.

TAR MACADAM, in the shape of tar penetration macadam has had a long and honorable history in American road building. Created to furnish a track for the early automobile, it has been built to carry the newer cars, and many of the older pavements are still in use. The re-tread is a newer member of the tar macadam family, being only about ten years old.

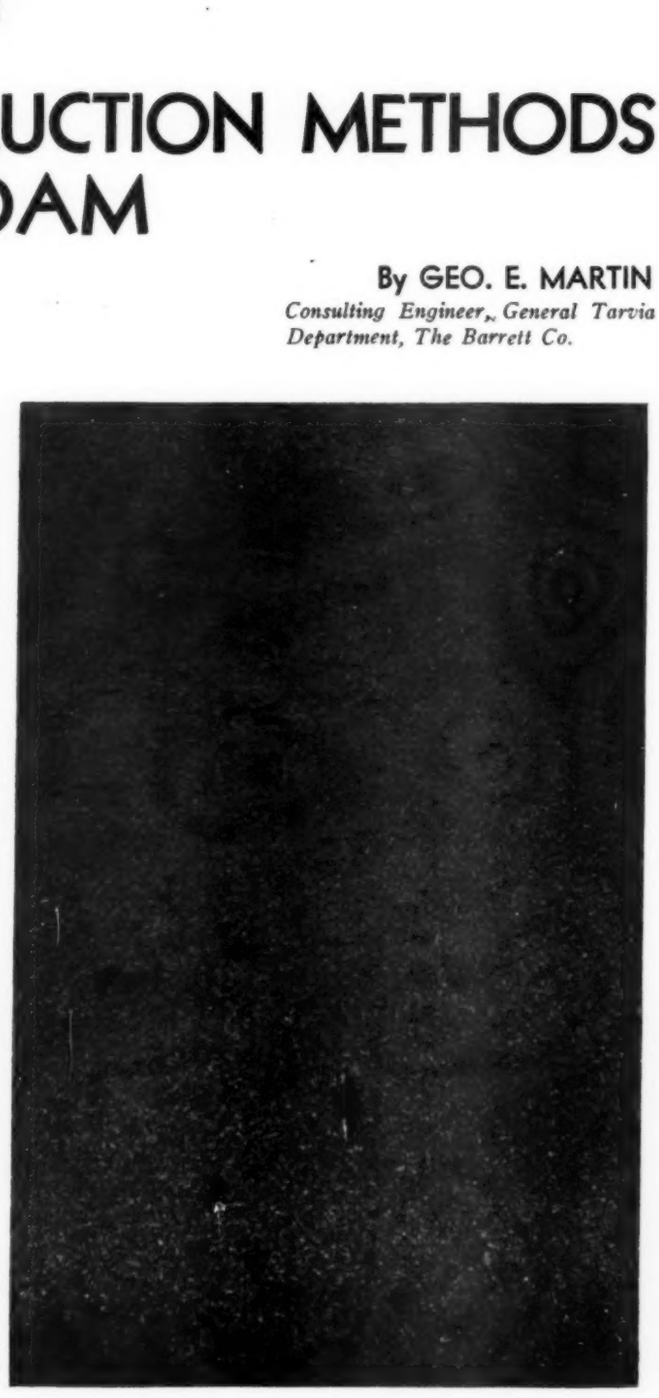
Within the past few years changing requirements and traffic demands have resulted in changed and improved methods of tar macadam construction. In the earlier days speed in construction was not so important. No one cared if it did take several weeks to finish a job, and no objection was made if the final seal coat had to be delayed until the next year. Now it is different. Highway engineers demand that the road be finished and ready for traffic in a short time and object strenuously to maintenance seal coats the next year. They are willing, moreover, to put sufficient men and equipment on the job to obtain the desired results.

Automobiles have also had their effect on the methods of construction. Average driving speed has probably increased 10 or 15 miles per hour in the past two years. This means that there is a greater tearing or abrasive action on the road surface. This removes the cover stone, unless it is securely anchored in place by the tar seal coat. Such action soon produces an open surface requiring an early maintenance seal coat.

Methods Modified—To meet these requirements, the methods of building tar macadam have been modified. These changes have been gradual but have been quite generally adopted by engineers using these types.

In order to speed up the work, the tars used for tar penetration macadam and for tar re-tread are now much heavier than those used a few years ago. This provides a quicker setting material which still permits the necessary manipulation to produce an easy riding road.

For producing a tight, self-sealing top on both types of the tar macadam, smaller choke stone for filling the surface voids and smaller cover stone on the seal coats are used. Two seal coats, instead of one, are used,



Surface of Improved Tar Penetration Macadam.

although the total amount of tar per square yard is not increased.

A Typical Example of Modern Methods—The following description of improved tar penetration macadam work in Monroe County, New York, is a typical example of the modern construction methods.

Careful preparation of the base and uniform spreading of the penetration stone will produce an easy riding surface. Irregularities in the foundation course will be carried into the top, so the place to start to build a smooth road is in the preparation of the foundation. The penetration stone should be uniformly spread by means of a box spreader or similar apparatus.

The penetration macadam aggregate will ordinarily range in size from 1¼ to 2½ in. in size, although in some instances a larger size is used.

Thorough rolling of the dry stone is a necessary part of the construction. The rolling operation locks and keys the stones tightly together. The road will not be solid until the stones are thus keyed together.

The tar used for the penetration macadam binder is a hot refined tar, with a float test of from 160 to 210 seconds at 50°C. This is somewhat heavier than the tar used in the past (100 to 160 seconds at 50° C.) so as to provide a material which will set up faster. The tar is applied at the rate of 1⅜ gal. per square yard for a depth of stone, which will be 3 in. deep after consolidation. The tar is applied at a temperature of approximately 250° F., and should not be overheated. Overheated tar, especially in hot weather, will run down to the bottom of the road and leave only a thin coating on the stone.

The surface voids are then filled with stone chips, ranging in size from ¼ to ⅝ in. Rolling is resumed and the stone chips swept into the voids during the rolling operations. The filling should be thoroughly done so that the following tar seal coat will be held on the surface where it is needed.

The seal coat of the same grade of tar as used in the penetration course is applied at the rate of ½ gal, per square yard. This seal coat is covered with stone chips ranging in size from ⅛ to ¼ in. is used. The cover is swept and rolled in place and the road opened to traffic.

This type of construction produces a very tight, close surface. However, due to the properties of the tar binder, it is a non-skid surface which will require a minimum of maintenance.

The Re-Tread Type—In the re-tread type heavier tars are also used. The first re-tread was built with a cold refined tar having a specific viscosity at 40° C. of 8 to 13. That is the same type of tar used for cold surface treatments. Building re-tread in those days was a leisurely occupation, which might spread over several weeks for a few miles of road and allowing time for the crew to go fishing while the tar set up enough to be rolled. True there often was no roller but the traffic did a fairly efficient job of consolidation, while the road was kept in shape with a drag or blade grader. From that method we have gone to tars with a specific viscosity of 50° C. of 26 to 36, or in many instances to a hot surface treatment tar with a float test at 32° C. of 60 to 150 seconds or even more. This requires not one blade grader pulled by a truck but three or more motor graders, so that the tar and stone may be mixed and shaped before the tar sets up.

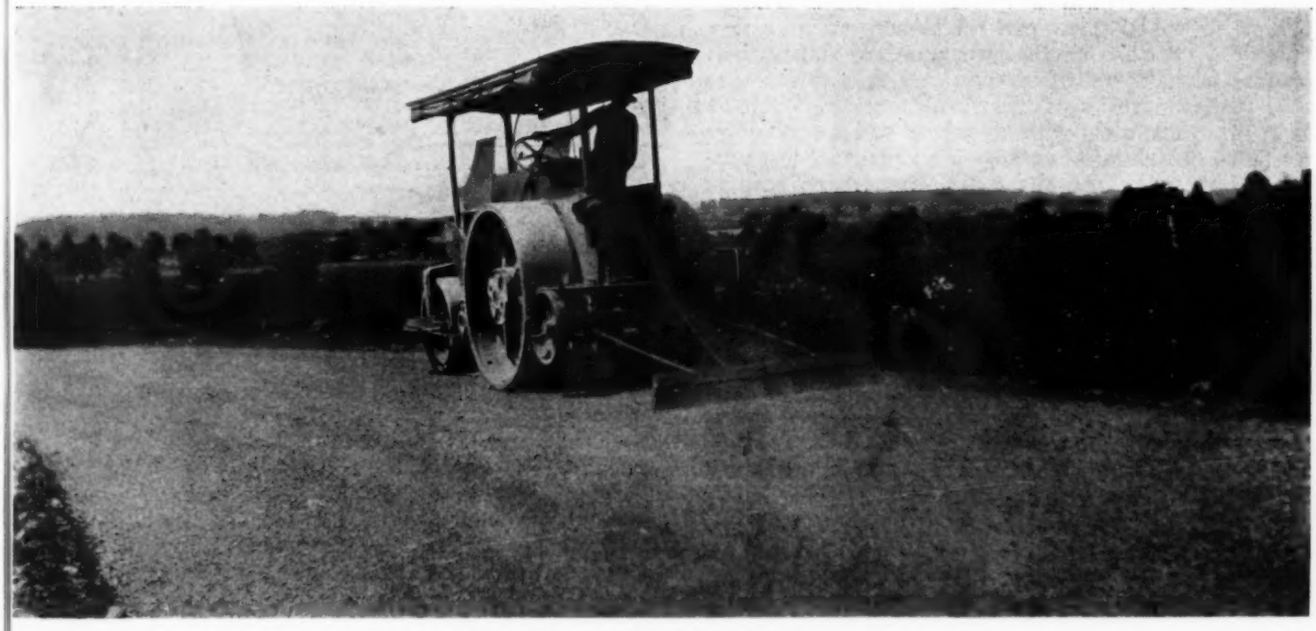
The tar required for a 3 in. depth of loose re-tread stone ½ in. to 1¼ in. in size is about ¾ gal. per square yard. This is generally applied in one application and mixing started at once. If the mixing is done in the morning, the road can be rolled during the afternoon under ordinary circumstances. Roller wheels must be kept wet to prevent picking up the tarred stone. Irregularities brought out by the rolling are corrected before the choke stone is applied.

For choke stone a clean stone or slag chip or pea gravel approximating the New York State No. 1 A stone, ranging in size between ⅛ in. to ¼ in. square mesh sieves seems to work best. This should be applied as soon as the preliminary rolling has been completed. The stone is thoroughly swept into the surface voids during the rolling.

The first seal of ¼ gal. per square yard of the same grade of tar as used for mixing is applied preferably the next day after the mixing operation. This is covered with the same size aggregate chips, swept and rolled in place.

Traffic may now be permitted over the road and will assist in closing up the surface.

Somewhat better results are obtained if the final seal can be delayed until the end of the job. This second



Sweeping and Rolling Choke Stone.

seal is ¼ gal. per square yard of the same grade of tar as used before. Covering aggregate is applied as in the case of the first seal and swept and rolled in place.

Procedure such as outlined above will result in an easy riding road with a tight, granular surface which will not require surface maintenance for some time.

Both types of tar macadam can be built rapidly and at no more expense than by the older and less satisfactory methods.

Some engineers may fear the production of a slippery surface when built in this manner. Small aggregate, tight tar surfaces are not slippery. The faces of the aggregate are always exposed on top and tires can get a firm grip on the road surface even when it is wet. It is not necessary to have large, knobby aggregate on the surface to produce a non-skid surface with tar.

These slight variations in construction practice have made possible faster and better tar macadam surfaces at no greater construction cost. In addition to this the maintenance costs have been reduced.

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Distance Required To Overtake and Pass Car

How much clearance is needed for one car to overtake and pass another car? Various figures such as 500 ft., 1,000 ft., etc., have occurred from time to time in traffic regulations, but apparently without any very good reason behind them. In Highway Research Abstracts for October, the results of several hundred measurements are given by H. C. Dickinson, Chief, Division of Heat and Power, National Bureau of Standards, Washington, D. C.

The typical case where risk is most generally involved seems to be that in which one driver is following another at a presumably safe distance awaiting a clear space ahead long enough to permit safely overtaking the slower vehicle or line of vehicles.

Under these conditions the maneuver of overtaking and passing involves accelerating the rear car until it overtakes and clears the car ahead then returning to its own traffic lane. The ability of most cars to accelerate is approximately constant over the usual speed range from, say 5 to 50 miles per hour, therefore, the time required to overtake another car must be substantially constant and independent of speed. This was found to be the case in a series of tests made some time ago in which two cars each with a driver and an observer were taken out on an essentially level road for test purposes. The procedure was to drive the car ahead at constant speed and overtake and pass it with the rear car making observations with a stop watch of the time from the beginning of acceleration to the return of the car into its own traffic lane ahead. This was repeated alternately by each car at speeds all the way from 5 miles per hour to 45 miles per hour.

Another series of time measurements was made in which the car was accelerated from its rear position, and the watch started at the instant when the forward bumper of the car in the rear came in line with the rear of the car ahead. This appears to be the last instant in the maneuver which permits the rear driver to safely change his mind in case of danger from an approaching car ahead.

In all these maneuvers the rear car, traveling at the same speed as the car ahead, started to accelerate from a position about 1½ seconds in time behind the car ahead. The time required to overtake and pass another car on a substantially level road, starting from a safe distance to the rear, is found to be very nearly six seconds and independent of the speed.

If these figures are reduced to distances, it is found that for a car to overtake and pass another traveling at 40 miles per hour on a road where speeds of 50 miles per hour may be expected, the driver intending to overtake must have at least 900 ft. of clear road ahead if the maneuver is to be performed with safety.

In overtaking a slower moving vehicle, say, a truck traveling at 20 miles per hour, the safe distance is 650 ft. made up of 200 ft. for the overtaking vehicles plus 450 ft. for a vehicle approaching at 50 miles per hour. On the other hand for maximum speeds above 50 miles per hour the safe distance is greater than 900 ft.

There are many parts of the United States where clear stretches of more than 900 ft. are rare. On such roads cars travelling at 40 or 50 miles per hour or above cannot overtake each other without grave risk. When cues of cars collect because of difficulties in this regard, the distance required and the dangers involved become much greater.

This illustrates one of the more obscure sources of danger which have to do with road design. Clear vision of the road ahead should be provided in so far as this can be accomplished.

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CAUSES OF HIGHWAY ACCIDENTS IN ENGLAND.—Defects in the road were responsible for 2½ per cent of the fatal road accidents in 1932 according to the May issue of the English publication Good Roads. The following tabulations from that issue, compiled by the National Safety First Association, shows the causes of accidents involving vehicles on the roads in England and Wales:

National Safety First Association Records (Ministry of Transport)

Causes of Fatal Road Accidents	1926 %	1927 %	1928 %	1929 %	1932 %	(six months) 1933 %
Failure of human element	84.6	82.9	81.6	84.6	85.8	84.1
Vehicle defects	4.8	3.9	7.0	2.5	5.4	5.2
Road defects	6.6	7.6	6.2	3.1	2.5	5.6
Weather	3.2	4.1	4.2	3.0	0.8	3.1
Miscellaneous	0.8	1.5	1.0	6.8	5.5	2.0
Causes due to:						
Drivers	36.6	36.0	39.1	33.2	31.9	32 1
Pedal cyclists	9.9	12.9	7.1	9.3	13.1	11.9
Pedestrians	38.1	34.0	35.4	40.1	39.2	39.1
Passengers	....*	....*	....*	1.2	1.2	1.0
Horse users	...*	....*	....*	0.8	0.4	0.02
Total	84.6	82.9	81.6	84.6	85.8	84.12

*Not tabulated.

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CAST IRON PAVEMENT IN ENGLAND.—According to the publication Highway and Bridges (London) of Sept. 11, cast iron pavement blocks have been used in several places in England where heavy traffic is found. The largest installation is in the Mersey Tunnel which was recently opened. The tunnel required 46,000 sq. yd. of pavement. The cast iron blocks used were Stanton Hard-Stud type, each block being 1 ft. square, 1⅞ in. deep and weighing 25 lb. The wearing surface is made up of diamond-shaped studs, 1 5/16 by ⅞ in., which are specially hardened by a patented process. The under side of the block is hollowed out and ribbed. A concrete base is used and the blocks are set in a thin layer of hot bituminous grout. Joints are filled with asphalt.

ADDITIONAL FEDERAL REGULATION OF INTERSTATE MOTOR TRANSPORT OPPOSED

PROPOSED legislation for the coordination of transportation agencies was the subject of a conference at the White House Oct. 17, in the course of which a committee, representing highway users, farmers, shippers, truck and bus operators, in every section of the country, advised President Roosevelt against further Federal regulation of interstate motor transport at this time.

The committee, which called on the President, spoke for the National Highway Users Conference and consisted of the following:

Herbert P. Sheets, Indianapolis, Ind., President of the National Retailers Council; Chester Gray, Washington representative of the American Farm Bureau Federation; Fred Brenckman, Washington representative of the National Grange; Arthur M. Hill, Charleston, West Virginia, President of the National Association of Motor Bus Operators; Ted V. Rodgers, Scranton, Pa., President of the American Trucking Associations, Inc., and Roy F. Britton, Director of the National Highway Users Conference.

In addition to their verbal presentation, the spokesmen for the conference submitted a brief, the highlights of which were as follows:

1. That interstate motor transport is now subject to code regulation, that great progress is being made in the elimination of improper practices and unfair competition, and that hurried Federal legislation would destroy the benefits and prevent the accumulation of experience and data which could be made the basis of intelligent legislation, if found necessary in the future.

2. That restrictive legislation would adversely affect employment, since there are today more than one million people employed in "for hire" bus and truck operations, or substantially as many as are employed by the railroads; and that the actual return to the railroads of the small volume of so-called lost business would not increase railroad employment by one man, the records showing that they actually decreased employment by 10.53 per cent during the heavy business period of 1923 to 1929.

3. That the demand for Federal regulation of rates and practices of interstate motor transport is primarily of railroad origin and is "an ill-advised effort to turn back to the railroads that small portion of business* they have lost by reason of more expeditious and more economical truck and bus services."

4. That the extent to which motor transportation has been a factor in the reduction of railroad business in recent years has been "grossly exaggerated," and that this loss has been more than offset by the large volume of business accruing to the railroads from motor transport sources.†

5. That the restriction of highway transportation services would result "in a great increase in the cost of transportation of passengers and commodities and would add to the delivery costs of millions of producers and consumers, which the business of the country can ill afford at this time."

6. That the rates for highway transportation "must be based exclusively on the cost of the service rendered," without reference to the rate structures of any other form of transportation.

7. That highway users are opposed to the placing of motor transport under the Interstate Commerce Commission, since the inevitable tendency under such a set-up would be "to freeeze highway rates at railroad levels," thus adversely affecting the public interest and particularly the interest of the farmers.

8. That no blanket form of regulation will fit the conditions, even as regards the "for hire" elements in the motor transportation industry, and that when the period of code regulation is over, bus operations should be dealt with in a separate and independent measure, if Federal legislation is found necessary.

9. That there is serious question as to the possibility of regulating the "for hire" elements in the motor trucking industry effectually "without unduly suppressing the operation of private vehicles used by agriculture and by industry as plant facilities."

10. That the "subsidization" argument advanced as a reason for the "equalization of competition between rail and motor carriers" wholly overlooks the fact that motor trucks and motor buses, while constituting only 13 per cent of all motor vehicles, pay $250,000,000 a year, or 25 per cent of all motor vehicle taxes.

The committee cited and indorsed the findings of the Joint Committee of Railroads and Highway Users, which, in its report of Jan. 30, 1933, said: that "No legislation

*The Federal Coordination of Transportation estimates that intercity trucks carry 9.4 per cent of the freight traffic of the country.

†As an offset to such business as the motor carriers have taken away from the railroads, it should be pointed out that thirteen per cent of railroad car-load revenue is derived from the production and use of motor vehicles and highway building. In a single year, the railroads receive from petroleum products alone more revenue than they receive from all the wheat, corn, oats, tobacco, cotton and potatoes transported in the United States.

should be enacted which has for its purpose the stifling of any legitimate form of transportation"; and also the findings of the National Transportation Committee, which, in its report of February 13, 1933, said: that "We cannot invent restrictions for the benefit of the railroads."

The brief to the President was joined in by members of the Advisory Committee of the National Highway Users Conference consisting of the following: Alfred P. Sloan, Jr. (Chairman), President, General Motors Corporation; Ernest N. Smith (Vice-Chairman), Executive Vice-President, American Automobile Association; L. J. Taber (Secretary-Treasurer), Master, The National Grange; Axtell J. Byles, President, American Petroleum Institute; Geroge E. Clinton, International Association of Milk Dealers; Emory Rice, American Bakers Association; C. O. Sherrill, Vice-President, Kroger Grocery & Baking Company; A. L. Viles, President, Rubber Manufacturers Association; and, William B. Warner, President, The National Publishers Association, Inc.; also, the following organizations: F. E. Mollin, Secretary, American National Live Stock Association; Charles F. Whiting, President, International Association of Milk Dealers; A. M. Loomis, Secretary, National Dairy Union; Donald Kane, Attorney, National Cooperative Milk Producers Federation; W. F. Jensen, Secretary-Manager, American Association of Creamery Butter Manufacturers; R. F. Sams, Jr., President, National Vegetable Growers Association; Ben F. Gordon, National Food Distributors Association; W. S. Campfield, Secretary, Eastern Apple Growers Council, and eighteen State Horticultural Societies; John M. Meighan, Secretary, National Association of Motor Bus Operators; Thos. P. Henry, President, American Automobile Association; Alfred Reeves, Vice-President, Automobile Manufacturers Association; B. H. Markham, Director, American Petroleum Industries Committee; J. E. Pennypacker, Managing Director, The Asphalt Institute; G. F. Schlesinger, Managing-Director, National Paving Brick Association; and W. T. Rogers, President, Motor and Equipment Manufacturers Association.

Highway Lighting in France

Several lighting installations have been made on highways in France. The one between Grasse, Cannes and Menton covers 37 miles and is stated to be the longest lighted section in Europe. The latest installation has been made on two sections of the highway between Paris and Versailles. One of these is a 1,500 meter section from Saint-Cloud to the entry of Ville d'Avray, equipped with the usual lighting system, and the other of 3,000 meters, between Ville d'Avray and Versailles, in which was employed, for the first time in France, a lighting system with sodium vapor lamps. The two sections are powered with two separate plants. On the Saint-Cloud-Ville d'Avray section the lights are placed in staggered fashion at intervals of about 165 feet. The height of the light is 26 feet, and the lamps employed are Mazda double filament capable of furnishing two different intensities: 200 and 500 watts.

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"Cement Bound Rubble" in San Bernardino, Calif.

A type of pavement called "cement bound rubble" has been built recently in San Bernardino County, Calif., with relief labor. Rock used on the project illustrated was obtained from clearing citrus groves. That which was unsuited for paving was used as fill for the paving.

First the subgrade is prepared, in the same way as for other types of paving. The rubble is then fitted in place, leaving only a small space between the pieces. The surface of the rubble is checked with templates, and any high spots tamped down, and wet down.

Voids are then filled and the surface is covered with a minimum of 1 in. of a 1-3 mortar. A drier mix is used for the surface than for the voids.

Careful checking has shown that voids with this method are under 20 per cent.

Work has been carried out by Howard Way, County Surveyor, and James Cole, County Road superintendent.

Below: After Subgrade Was Prepared, Rubble Stone Was Laid in Place as Tight as Possible.

Left: Surface Was Checked with Templates. High Spots Were Tamped Down and the Rubble Wetted.

Right: The Surface Was Finished with a Wood Float.

Above: The Rubble Base Was Flooded with Mortar and a Minimum of 1 in. Broomed Over the Surface.

30-FT. CONCRETE PAVEMENT PLACED FULL WIDTH IN SINGLE OPERATION

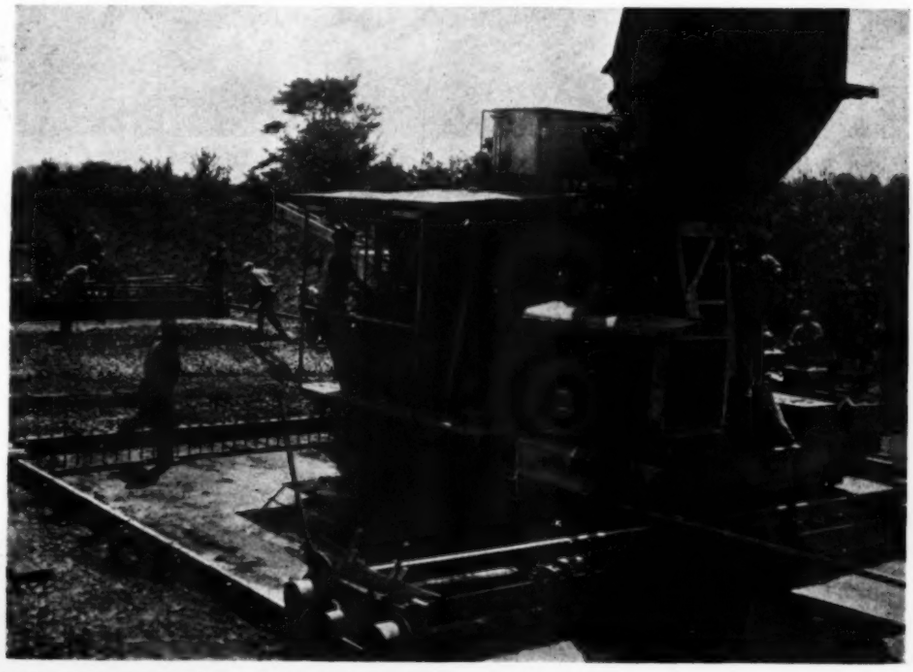
THE building of Pensylvania's longest continuous stretch of three-lane, high-type pavement on the state's road system has been completed ahead of schedule. This early completion resulted from the use of latest methods of construction and equipment.

Excellent as the project is, it is scarcely a beginning in solving the congestion on major roads of the state. A thorough study of traffic, made cooperatively by the U. S. Bureau of Public Roads and the Pennsylvania State Highway Department, shows a total of 890 miles of roads in the state on which traffic exceeds that of the Pittsburgh-Butler road, which serves 300,000 car owners in Allegheny and Butler counties.

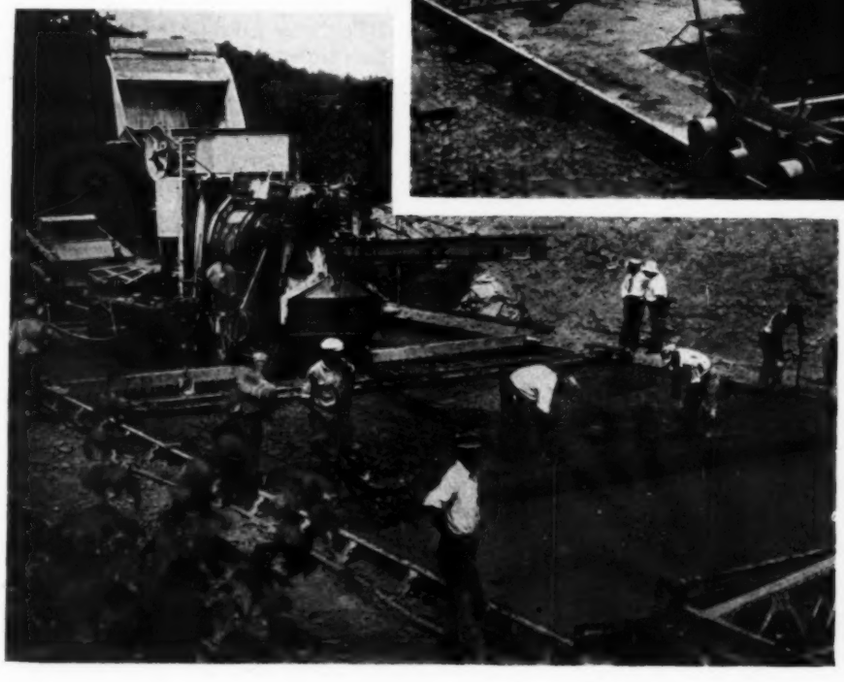
Yet the latest published report of the U. S. Bureau of Public Roads shows only 83 miles of roads in the state wider than two-lane. Ranking third in motor vehicle registration, with dense population, the state ranks twelfth in mileage of wide roads.

Traffic on Route 8 northward from Pittsburgh has demanded an extra-width, modern surface for several years. The project just completed is the result of continued demands of the William Flinn Highway Association and the Pittsburgh Motor Club, cooperating with the State Highway Department in getting relocation and widening.

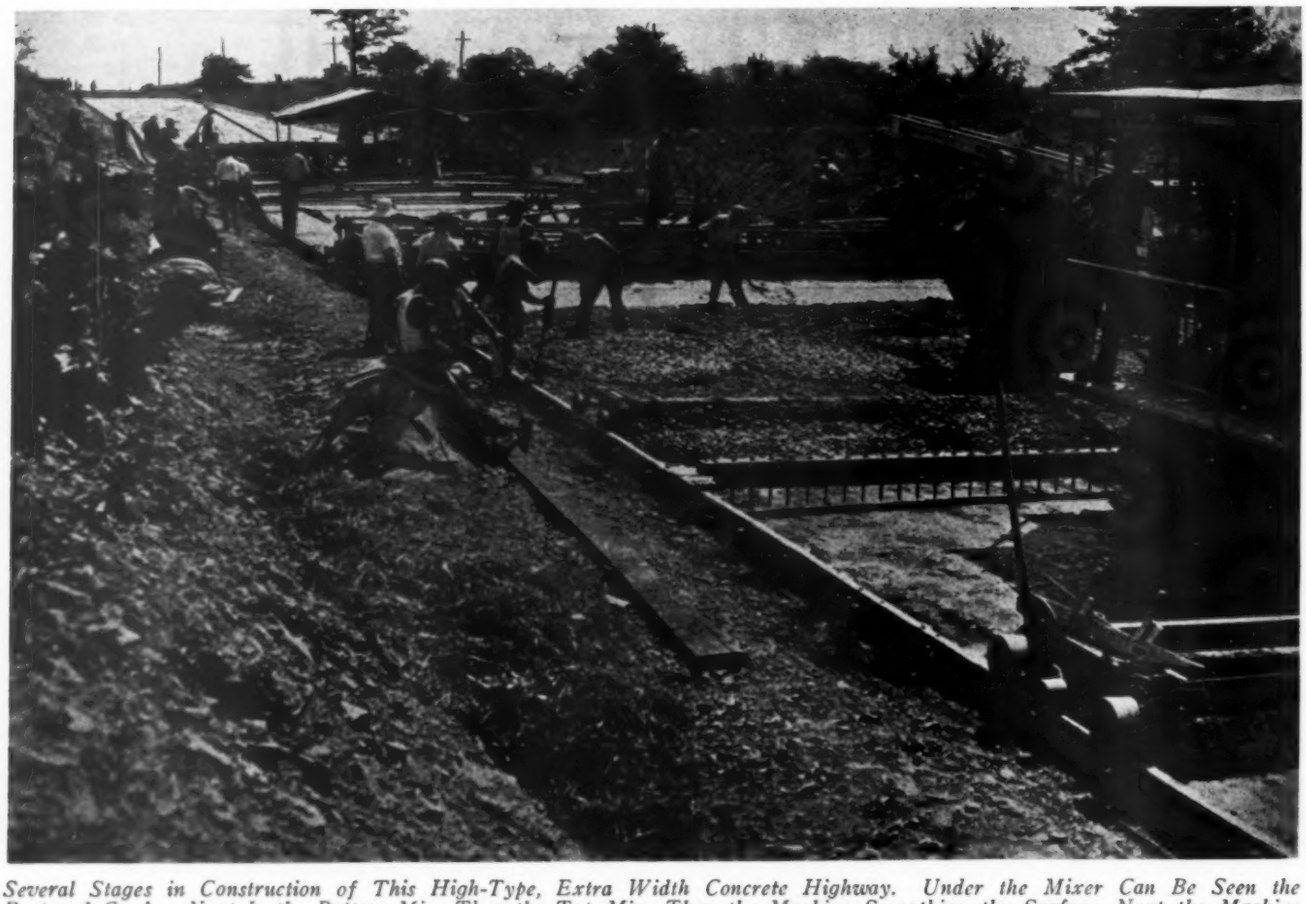
Present Construction.—The present work consists of paving the last 14.37 miles of the project, which was carried out under three contracts: widening and repav-



Right: Dual Drum Concrete Mixer Constructing 30-ft. Pavement on Route 8 Near Butler, Penn., for State Highway Department.



Laying 30 ft. of Concrete All the Way Across the Highway on Route 8 Between Pittsburgh and Butler



Several Stages in Construction of This High-Type, Extra Width Concrete Highway. Under the Mixer Can Be Seen the Prepared Grade. Next Is the Bottom Mix, Then the Top Mix, Then the Machine Smoothing the Surface, Next the Machine Cutting Expansion Joints, the Finished Road, and Last the Surface Covered with Straw in Preparation for Curing

ing a narrow cobblestone link in Etna; paving 1½ miles into Butler; and construction of 12 miles north from the Allegheny County line.

This last section is the largest single contract ever awarded by the Pennsylvania Department of Highways. The concrete surface replaces a 16 to 18 ft. patched and repatched pavement, treacherous in fog, curves without superelevation, a road cut by rail crossings and intersecting local roads, and full of blind curves.

New Road to Save Motorists 30 Minutes in Travel Time.—Traffic experts estimate a saving of 30 minutes will be made in driving time between these cities through widening, realignment, reduction of curvature, and improved gradient. Three main lane railroad crossings are eliminated. And a highway grade separation, one of the few in the states, separate cross motor traffic on the busy Allegheny County highway.

This is the first time 30 ft. of concrete pavement has been placed all the way across in a single operation in the state. The cross section is a three-lane design with 9-7-9 in. thickened edges.

On the largest of three contracts, subgrade preparations, mixing, placing and finishing are all scheduled to enable work to proceed the full width of the surface without interruption.

Dual Drum Concrete Mixer Used.—Two-course construction was specified. The contractor decided on the use of a dual drum Ransome concrete paver, which mixes the batch part of the time in one drum and the balance of the time in another drum. From the latter it is discharged into a spreading bucket operating on the boom. Batches were delivered by truck to the mixer.

With this set-up, as high as 1,022 lin. ft. of 30 ft. pavement have been placed during an elapsed time of 13 hours and 2 minutes on a single day.

This contract was completed by the York Engineering & Construction Co. of York, Pa. The balance of the Butler County section was built by the Holmes Construction Co. of Wooster, O.

Construction of the Allegheny County sections of this highway were under the supervision of H. E. Klosa, District Engineer of the Pennsylvania Department of Highways, the Butler County end being supervised by E. J. Finn, District Engineer.

View of the Completed Route 8 Ner the Succop Farm, North of the Allegheny County Farm

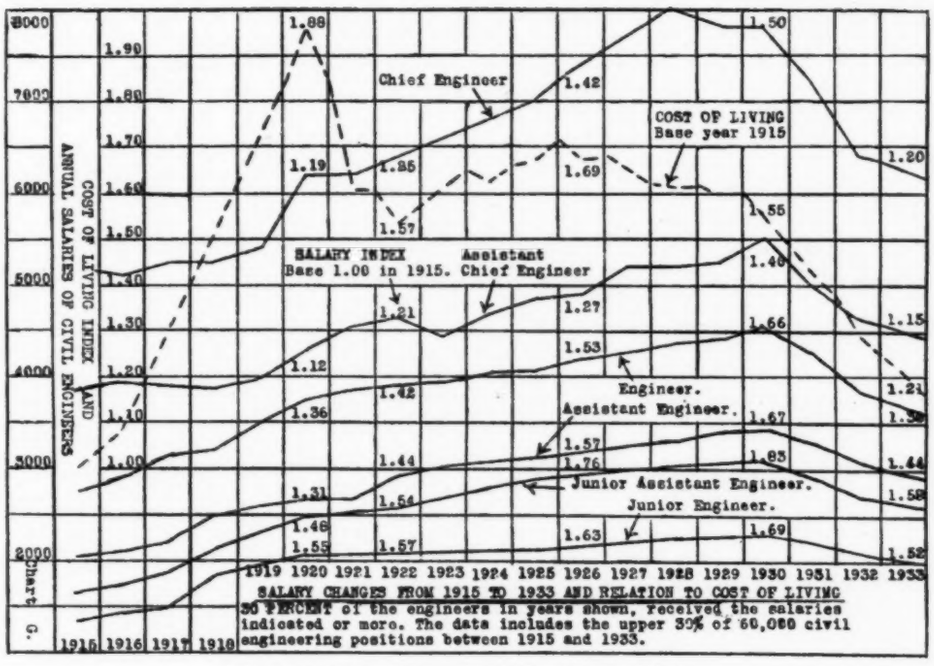

COST OF LIVING INDEX AND ANNUAL SALARIES OF CIVIL ENGINEERS
Chief Engineer
COST OF LIVING
Base year 1915
SALARY INDEX
Base 1.00 in 1915.
Assistant
Chief Engineer
Engineer.
Assistant Engineer.
Junior Assistant Engineer.
Junior Engineer.
1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933
1916 1916 1917 1918
SALARY CHANGES FROM 1915 TO 1933 AND RELATION TO COST OF LIVING
50 PERCENT of the engineers in years shown, received the salaries indicated or more. The data includes the upper 30% of 60,000 civil engineering positions between 1915 and 1933.
Chart G.

Chart of Salary Changes and the Cost of Living

TRENDS IN ENGINEERING SALARIES AND COMPARISON WITH COST OF LIVING

THE average civil engineer with a job in 1933 was better off in one vital respect than in 1930, for during that interim engineering salaries declined less than the cost of living. He was much better off than in 1920—the peak year for living costs—for his salary had advanced steadily until 1930. If he was not burdened with excessive interest payments or taxes, these changes represented almost clear gain; but it is to be feared that few reaped such full benefit.

Average salary reductions, according to statistics compiled by Mr. Arthur Richards, Research Director, New Jersey Taxpayers Association, ranged from 21 percent in the higher engineering grades to 10 percent in the lowest—all for the 3 year period 1930 to 1933; while the cost of living, at the same time, dropped 22 percent.

Nineteen thirty-three salaries in all grades were back almost exactly to their 1920 levels; but all showed substantial gains over 1915, Mr. Richards' base year. Only in the 2 highest grades (chief engineer and assistant chief engineer) was the percentage of salary increase less than the cost of living increase from 1915 to 1933.

All this may be scant consolation to the engineer out of work and wondering how to feed his family; to the jealous minded it may even be added bitterness. But to the profession it is a subject for sincere congratulation, for it indicates that a huge surplus of available service has not brought price demoralization. What, one may ask, has happened to the law of supply and demand?

The really unfortunate salary period was from 1916 to 1927 or 1928, in which the cost of living index was generally above the salary index. The climax occurred in 1920, when living costs averaged 1.88 and salary indexes ranged from 1.12 to 1.55—all measured from a base of 1.00 in 1915.

The chart exhibiting these data is reproduced herewith. It is from a paper entitled "The Effect of the Depression on Compensation and Employment of Engineers in Public Service" presented by Arthur Richards at the National Congress of the American Society of Municipal Engineers and the International Association of Public Works Officials held at Rochester, New York on Sept. 24.

The paper contains numerous other charts with explanatory texts relating to engineering salaries and employment—chiefly for engineers in federal, state, county or city employ.

Regarding his sources of information the author says, "In order to secure accurate information on the matters considered, many kinds of questionnaires were sent to various persons and organizations throughout the county, and also many public statistics which relate to the general subject were examined. The data is, therefore, very representative, and, so far as is known, gives a reliable cross section of conditions in the engineering profession as related to public service or employ."

One chart shows the extent of salary reductions suf-

fered by engineers in public employ throughout the entire country from 1930 to 1934. It indicates that 90 percent of the salaries were cut 10 percent or more, 50 percent were cut 16 percent or more, 25 percent were cut 23 percent or more, and only about 12 percent were cut 30 percent or more. In the State of New Jersey 10,217 salaried employees (engineers and others) of cities and counties fared substantially better, only 82 percent of their salaries being cut 10 percent or more, 33 percent being cut 16 percent or more, and less than 2 percent being cut 30 percent or more. New Jersey State employees have already had their cuts restored.

Regarding the New Jersey situation, Mr. Richards says, "The State of New Jersey, which had a varying percentage reduction schedule in effect for the past few years extending from one percent on salaries up to $1,200, to 10 percent on salaries over $4,500, and which applied to practically all state employees, eliminated the reductions effective July 1, 1934. Therefore, if economic conditions improve to any appreciable extent during the last half of 1934, it is logical to assume that many of the salary reductions which have been in effect for the past few years for county and municipal employees may be restored, and salaries may revert to the base schedules of 1930 or 1931."

Mr. Richards offered very little of analysis or deduction, apparently preferring to let others draw their own conclusions from his statistics; and this, at the moment, is perhaps the wisest course. Still one would be prone to consider the opinions of a man who has compiled so carefully and presented his data so clearly.

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First Street Lighting Installation Incorporating High-Intensity Mercury Vapor Lamps

The first street lighting installation in America incorporating high-intensity mercury vapor lights has been made in front of the new post office at Lynn, Mass., where eight of the units have been put in service by the Lynn Gas & Electric Co. To the casual observer the lighted units seem to differ little if any from the more usual bright lights found in white way lighting installations; but to the engineer the new units represent a decided advance in the lighting art, incorporating as they do an increase of approximately 50 per cent in the output of light of the complete unit.

The units externally differ none from the usual ornamental street lighting globes. Within, however, are contained two lighting units—one of the new mercury vapor lamps and one of the usual incandescent lamps. The combination of the two types of light emitted by these radically different units, blended within the ornamental fixture, gives a white light.

The mercury lamp, used by itself, is an efficient producer of bright, slightly bluish green, white light. Its quality is much closer to white than that produced by the low-pressure type of mercury lamp with which the public has been familiar, the light from which is much more bluish. Addition of the incandescent lamp within the fixture contributes a certain amount of yellowish and reddish light, improving the color rendition and more closely approximating daylight. In fact, resultant color changes are no more apparent than with ordinary lighting.

The mercury vapor lamp is rated at 400 watts, and produces 14,000 lumens, or units of light; the incandescent lamp is rated at 200 watts, and produces approximately 3,400 lumens. The combination gives 29 lumens per watt, about half again as much light as would be obtained from incandescent lamps alone.

The high intensity mercury vapor lamp is a glass tube approximately 1 ft. long and 2 in. in diameter and having a large, or mogul, screw base. It is mounted base down within the lighting fixture. Within the outer bulb is another sealed bulb, approximately 7 in. long and 1⅜ in. diameter, within which the arc takes place. During operation the mercury vapor it contains is at approximately atmospheric pressure; between the two bulbs of heat resisting glass the gas is at reduced pressure. Above this mercury lamp is mounted the incandescent lamp and its reflector, base upward.

The high intensity mercury vapor lamp incorporates the latest developments of the research and illuminating laboratories of the General Electric and General Electric Vapor Lamp companies. Just as it differs greatly from the low intensity mercury vapor lamp which has been in use for years in industrial lighting, so does it differ from the sodium vapor light, introduced by the General Electric Co. a year ago for rural and state highway illumination. Although of even higher efficiency, the sodium lamp has a characteristic orange-yellow glow and is mono-chromatic in nature, which makes it inapplicable to uses where color is a factor. The mercury vapor luminaire introduced at Lynn retains a high efficiency characteristic and affords a comparatively white light in which other colors of the spectrum are included. It is far smaller than the sodium-vapor lighting unit, is decidedly different in operation, and is intended for different applications.

The mercury lamps are manufactured by the General Electric Vapor Company at Hoboken, N. J., and the lighting fixtures by the Street Lighting Department of the General Electric Co. at Lynn, Mass.

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Official Nominations for Officers A. R. B. A.

The official nominations for officers for 1935-1936 and directors for three years of the American Road Builders' Association, submitted by the Nominating Committee elected at the Chicago Convention, are as follows:

For President, Wm. P. McDonald, President, Wm. P. MacDonald Construction Co., New York, N. Y.

For Vice-Presidents: Paul B. Reinhold, Secretary-Treasurer, Reinhold & Co., Inc., Pittsburgh, Pa.; George Pou, Attorney, Raleigh, N. C.; Grover C. Dillman, Director of Public Service, Grand Rapids, Mich.; Stanley Abel, Supervisor, Fourth District, Kern County, Taft, Cal.

For Treasurer, James H. MacDonald, Consulting Road and Paving Expert, New Haven, Conn.

For Directors, term ending 1938: Edward Costigan, Corson & Gruman, Washington, D. C.; Arthur W. Dean, Chief Engineer, Massachusetts Department of Public Works, Boston, Mass.; Frederick Hoitt, Secretary, New England Road Builders' Association, Boston, Mass.; Charles T. Hvass, President, Chas. Hvass & Co., New York, N. Y.; T. S. O'Connell, State Highway Engineer, Phoenix, Ariz.; Thos. S. Stephenson, Editor, Pennsylvania Road Builder, Altoona, Pa.; Chas. M. Upham, Engineer-Director, American Road Builders' Association, Washington, D. C.

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ALASKA—ARGENTINA HIGHWAY—An international highway extending from Fairbanks, Alaska, to Buenos Aires, Argentina, looms as a probability within the next few years, according to the Automobile Club of Southern California.

Paver and Roller Working Near Together

NEW INDIANA PAVEMENT CONSTRUCTION Has Asphalt Center Strip With Concrete Sides

A TWENTY ft. strip of asphalt with 10 ft. of concrete on each side is the somewhat unusual design adopted for the pavement of Ridge Road for a distance of 3.83 miles westward from Gary, Ind., under what is known as "N. R. H. M. Project 104, Section F." This is a part of United States Highway Route 6, and the work is being done with federal aid under the supervision of the Highway Commission of Indiana. A total of 4,500 ft., designated as the "N. R. M. portion," lies within the municipalities of Gary and Griffith; while the remainder—the "N. R. H." portion, totalling 15,700 ft.—is state highway. An additional 1,300 ft. of concrete pavement at an overhead crossing of the Nickel Plate Railway brings the total length to 4.07 miles.

Some of the construction methods, as well as the design, are of special interest. The project is now nearing completion.

Design of Pavement.—The combination of asphalt and concrete was selected because the old Ridge Road pavement—a 20 ft. strip., part bituminous and part water-bound macadam—afforded an excellent foundation for new asphalt; while the nearly pure sand composing the natural soil at the sides indicated a concrete slab as most practical. The sharp contrast in pavement color should help to keep traffic in its proper lanes: it will be interesting to learn if it does so.

Only two important departures from the old grade and alignment were found necessary. One of these is at the Nickel Plate Ry. crossing, where the approaches are on sand fill, and the entire width is paved with concrete. The other is at a cemetery, where, for right of way reasons, the center line was shifted 10 ft., and one-half of the old pavement was broken up, transferred to the opposite side, and relaid as macadam to complete the foundation for the asphalt strip.

The width of right of way varies from 80 to 100 ft. An earth shoulder is extended 8 ft. beyond the concrete on each side, thus leaving from 12 to 22 ft. for ditch and back slope.

Each 10 ft. concrete strip is 7 in. thick at the center and 9 in. at each edge. Marginal bars at outer edges constitute the only reinforcement. The concrete strips were completed and put into service before work was begun on the asphalt, thus facilitating construction of the latter and producing minimum interference with general traffic.

The 20 ft. asphalt section consists of a 2 in. asphaltic macadam top on an emulsion base course, which is normally 3 in. thick but varies somewhat because of irregularities in the foundation. The finished surface of the asphalt section is ¼ inch above the adjoining concrete.

Asphalt Base Course.—The base course is composed of limestone coated with Mexican base (Texas Company) bitumen, emulsified with rosin oil soap, and having a penetration of 100 to 120. The stone is sized from 1½ in. down, and weighs about 2,400 lb. per cu. yd. It was from the quarry of the Moulding-Brownell Co. at Thornton, Ill. The material was plant-mixed in 800 lb. batches, the emulsion comprising about 5 per cent of the total. Haul from the plant ranged from 1¼ to 7¼ miles, and was done chiefly with 6-ton trucks.

The base was laid in three courses of approximately 1 in. each, the first being applied directly to the foundation after the latter had been evened up by filling holes and depressions with the base mixture.

Ridge Road near Gary, Indiana, Showing Asphalt Base Course in Foreground, Top Course at Right in Process of Rolling, Completed Pavement in Background, Concrete Strips at Each Side.

The material was placed with an Adnun black top paver, which permitted a very close adjustment of the thickness deposited. This was an especial advantage in view of the fact that as a measure of economy, the profile of the new pavement had been made to conform as closely as possible to the old, and has, therefore, a large number of small vertical curves.

It should be noted in passing that these curves are observable by eye in the concrete sections before the finish course of asphalt is laid adjoining them; but that after completion of the finish course, they are not observable. They seem to have no effect on the riding qualities of the pavement at speeds below 50 miles per hour, but are noticed in some cases at higher speeds.

Each 1 in. course of base material was rolled with a 10-ton roller. As the stone ranged up to 1½ in. in size, it is evident that excellent compacting, and probably also some crushing, were necessary in order to bring the finished base to proper level. On good days, a mile or more of 1 in. base layer was laid in 10 hours. The average for the 3 layers of finished base was about ¼ mile, or 3,000 sq. yd. per day.

Asphalt Top Course.—Composition of the 2 in. asphalt macadam top course is as follows:

	Per Cent
Crushed limestone, sized ½ in. down	55
Fine concrete sand	38½
Bitumen, 60 to 70 penetration	6½

The stone was furnished by Moulding-Brownell Co.—the bitumen by Standard Oil of Indiana. They are mixed at the same plant, and require the same haul as the base course. The mixture is placed with the Adnun paver and rolled with the 10-ton Buffalo-Springfield steam roller. About 2,500 sq. yd. of top construction is the average per 10-hour day.

Procedure is as follows: A truck loaded with 6 to 9 tons of materials at a temperature of about 275° F. is backed along the completed base, and discharges about 3 tons directly into the hopper of the paving machine. The truck then pulls ahead, and the paver advances, depositing a 10 ft. strip of material between the concrete and the center line of the roadway. This material is deposited with great uniformity, and is smoothed to an even surface by the transverse oscillating bar of the machine. It is left higher than the final finished surface in order to provide for a 25 per cent compression under the 10-ton roller. The paving machine's two broad supporting rollers leave tracks which are obliterated when the steam roller passes over them.

A very small amount of hand work is required. The vertical edge of the concrete is painted before the asphalt paving material is deposited against it; laborers help distribute the charge in the paving machine hopper; template measurements are made on the base to determine the exact thickness of top required and the machine adjustment necessary to produce it; a workman with a rake follows the machine, sets up the joint and pushes over any bits of material which may be scattered on the adjoining concrete; and there are, of course, various odds and ends of work requiring attention; but all of this is handled with ease by four laborers.

The steam roller follows immediately after the paving machine, and works right up to it.

After one-half the top is laid for a distance varying from 50 to 350 ft., depending on weather temperature, the paver is moved over, and the other half is filled in. There is an inconspicuous joint at the center line between the separately laid portions.

Inspection is rigid. A surface variation of ¼ in. under a 10 ft. straight edge in a longitudinal position is permitted but there is no tolerance laterally.

Contractor, Crew, Working Time and Personnel.—The Rieth-Riley Construction Company, Goshen, Ind., is the contractor on the entire job—grading, concrete, asphalt and bridges. Work is under NRA rules, all labor being limited to a 30-hour week. The working day is 10 hours, with common labor in two shifts of 5 hours each, while skilled laborers work the full 10 hours for three days and then lay off for the remaining three. Supervisory services are not limited in working time. A slight reduction in labor efficiency is noticed under the 5-hour day—there being a tendency among the men toward carelessness and "leaving it for the next guy." The work is taking about 6 months for completion, grading having been begun in April, concrete work about the middle of June, and asphalt the last week in August; the whole being completed as this November issue of ROADS AND STREETS goes to press, excepting for one large bridge and its approaches.

The crew on the asphalt top finish job consists of 7 men:

1 Foreman
1 Paving machine operator
1 Steam roller operator
4 Laborers

All hauling is done by the Jansma Cartage Company, Munster, Ind., four 6-ton trucks and one 9-ton truck being used.

A. O. Krogh is the contractor's superintendent on asphalt work, and Howard E. Smith is foreman. D. T. Good superintends concrete, and C. Paulison, bridges.

Oliver Downs is District Engineer for the state, with headquarters at La Port, Ind.; Boyd Phelps is assistant district engineer in charge of roads; C. H. Sweeney, Supervising Engineer; E. M. Peck, project engineer, and C. E. Craeger, inspector.

Charging the Paver on Top Course Work

SAND CUSHIONS AS PROTECTION AGAINST FROST HEAVING

EXPERIMENTS to determine the efficiency of a sound cushion to eliminate the action of frost in the ground were made two years ago by the Provincial Department of Roads of Quebec. It was figured that if a sand cushion from 6 to 12 in. deep, according to the nature of the subsoil, would reduce heaving enough to prevent cracking of an asphalt or concrete pavement the problem would be solved with reasonable expenditure.

How the Tests Were Made.—Locations for the experiments were chosen to insure the maximum amount of water in the ground with necessary exposure to make the best conditions for the test. The locations chosen were: (1) in the clay district of Nicolet; (2) in the loamy lane of Lennoxville, and (3) in the more or less swampy lane near Victoriaville. The test sections were constructed as follows: After removing the sod from the surface, sand and gravel were laid on three series of three squares of 30 ft. As follows: The first three squares were covered with clean sand 6 in., 9 in., and 12 in. deep. The second series was covered with 6 in., 9 in., and 12 in. of loose gravel. The last series was covered with the same amount of sands as the first over which about 9 in. of gravel was laid and compacted as much as possible. Two additional squares, one with the sod removed and the other left in its natural condition were also tested. A piece of braid was carefully set in the middle of each square to take levels, and the snow was removed almost entirely from the surface of each square after every storm. Levels were taken about every two weeks during the winter. The results were tabulated and a diagram drawn to facilitate the comparison. Alphonse Paradis, Chief Engineer, Quebec Department of Roads, in a paper presented to the 21st convention of the Canadian Good Roads Association, stated that this diagram showed: that uncovered sand is not very effective as an insulator, probably due to the action of the wind. Uncovered loose gravel is still less effective, but sand covered with packed gravel reduces the frost action to such an extent as to make it a good protection against heaving. Further extracts from Mr. Paradis' paper follow:

Important Highways Built with Sand Cushion.—On the basis of those experiments, specifications have been worked out calling for a sand cushion on all important highway projects. That method has been applied for two years and the lower temperature of last winter was a very good test, being the severest winter for seventy years. Sections of highways have been built with sand cushion in 1932-34, in Quebec province as follows:

Highway No. 1, from Magog to Granby, 30 miles.

Highway No. 48, between Joliette and L'Assomption, about 6 miles.

Highway No. 8, between Masson and Thurso, 6 miles.

Highway No. 2, just east of Three Rivers, 6 miles.

Highway No. 3, as Contrecoeur, about 6 miles.

None of these sections showed any sign of heaving last spring. In addition to the sections above mentioned, two sections of concrete paving were laid over a sand cushion, first at Cap de la Madeleine, on Highway No. 2, and second at Ville LaSalle, near Montreal Highway No. 4. The first section was laid last fall on 12 in. of sand on very bad ground, no reinforcement being used except tie-bars across longitudinal joints. That section did not heave although an adjoining stretch laid some years ago, without sand, raises every winter so badly that barricades had to be installed at some places to avoid accidents. The work at Ville LaSalle, is done the same way, except that the sand is only 8 in. deep. The cross-section of the pavement has a uniform thickness of 8 in.

When and where sand should be used depends upon the nature of the subsoil, the intensity and weight of traffic, the climate and the type of surfacing that is to be built. Probably the central point breaks through. Consequently, the increasing number and weight of vehicles on our roads is making this problem more acute.

Studies Should Be Made Before Drawing Specifications.—The nature of the soil and the topographical condition of the country should be studied carefully before drawing specifications on the practical means to be applied against frost action. Porous soils, as gravel, sand and gravelly loam with proper surface and underdrainage, will not need additional protection. Sandy loam is not to be trusted. Free water must be drained out in any case. All saturated soils, even gravel, will allow the formation of ice lenses within its mass. Of course, gravel and sand shed water so freely that they are seldom found in a saturated condition in the roadbed. In flat countries, drainage is rendered difficult through the lack of proper slope towards natural outlets, but the water level can generally be lowered to a certain extent and the engineer must decide if additional protection is needed. In hilly or rolling country, rock is the biggest difficulty. Solid rock ridges, sometimes close to the surface, spread across the road in a very irregular shape, often making dams for underground water. Such wet basins should be drained out by all means because they keep the soil in a saturated condition by the afflux of underground currents during winter months. Prob-

ably the most practical method of drainage in those cases is to crack the rock by blasting below the frost level in the ditches. When proper drainage of free water has been done, there remains for the engineer to determine where and to what extent the process should be applied. In or near earth cuts, the water level is always close to the surface; while on fills of a few feet, the subsoil is drained easily below the frost level. I should say, however, that, on account of our very low winter temperature, a costly pavement should not be laid, in this province, on a clay fill without a sand cushion of a few inches to prevent contraction cracks.

On non-porous soils such as clay and silt, I would not hesitate to recommend the sand cushion method throughout the whole length of the road taking care to increase the thickness of the sand wherever the water content of the soil, and exposure, will require it.

Placing the Sand Cushion.—Sand may be laid the full width of the road-bed, say about 32 ft. for a 20-ft. pavement or else in a trench about 22 ft. wide for a 20 ft. pavement. This latter process is less expensive, but may cause trouble during construction on account of the trench holding rain water. The thickness of the sand cushion may vary from 6 in. to 12 in. although we seldom go over 8 in. on most of our roads where that method is applied, and the results are entirely satisfactory so far. On unimportant roads to be improved with gravel and which will remain gravel roads for a long time, the cost of the sand cushion would be out of proportion to the advantages derived from it. Those roads having light traffic are not subject to much disturbance by frost boils and the repairs are so easily effected that the most economical method in such cases is to keep the old system of laying gravel directly on the road bed and run the risk of some minor repairs at springtime.

The cost of a sand cushion varies considerably accordnig to the distance of drawing the material. It may run from 50 cents to $1.50 a cubic yard delivered on the road. Loading, unloading and spreading is a very simple matter. We might say that $1 a cubic yard is a fair average price. Then, the cost of an 8 in. sand cushion 32 ft. wide would be about $4,000 per mile. If the cushion is laid in a trench 22 ft. wide, the cost would be about $3,400 per mile including trenching and shouldering. This last method is less expensive, but not so effective.

To obtain good results, it is most important that the cushion be done very carefully. The subgrade must be as nearly perfect as possible and the spreading of the sand must be very uniform. The first layer of foundation material, whether it be gravel or crushed stone, should follow immediately the spreading of the sand to allow the least possible amount of traffic over it. Trucks hauling materials should not be allowed to run over the uncovered sand, if at all possible. This can be done by hauling sand over the subgrade, turning the trucks on a turn-table and backing up to the unloading point. Doing the same thing with the gravel trucks from the other end of the job eliminates entirely the passing of trucks over the loose sand. When all the hauling has to be done from the same end, gravel trucks must back up over the sand to unload. In that case, ruts made in the sand by the gravel trucks must be filled and the surface corrected carefully before spreading the gravel. The installation of a turn-table is not costly, the operation is simple and causes no appreciable delay.

Principle of the Sand Cushion.—The principle of the sand cushion rests on the fact that the material used contains a certain proportion of voids which must be retained indefinitely. Sand is the ideal construction material for that purpose. Gravel and broken stone also contains a large proportion of voids, but on account of the coarseness of the material they are much less effective and the tendency is for those materials to clog up, by earth coming from the subgrade, or through compaction during the construction. Moreover large voids in the lower course of foundation will allow fine materials from the upper course to work their way in the lower course and thus disturb the whole mass, and endanger the surface.

Fine, loose gravel may be used for the sand cushion wherever sand is not available at normal cost. Although not as effective, a layer of fine gravel will serve the purpose if laid thick enough and care be taken to avoid compaction during construction.

Judging from the experiments loose gravel is not very satisfactory, but had it been covered with a layer of compacted gravel, the results would likely have been much different.

That method was used on Highway No. 1 near Granby and near Eastman. Crushed gravel was laid 18 in. thick in a single layer. After compaction by dragging, we found about 8 in. of compacted gravel at the surface and between 7 in. and 8 in. of loose gravel at the bottom. That road has not been disturbed by frost since it was built. However, I would advocate the use of sand as it has a much lower thermal conductivity than any other road building material. (0.38 for quartz sand compared to 2.58 for loose dry gravel.)

On sand may be laid any type of foundation generally used in road construction. Gravel, crushed stone, cobble stone, clinkers, etc. Gravel foundations built in Quebec were laid from 10 in. to 8 in. deep, measured loose, and compacted with an ordinary horse-drag, very light and easy to handle. The compaction should be started immediately after spreading and continued without interruption until completed. It is a known fact that gravel packs from the bottom to the top and the thickness of the compacted layer depends upon the penetration of horses' hoofs and wheels of trucks in the loose gravel. As a rule not more than 9 in. or 10 in. of loose gravel can be packed at one time, giving a finished thickness of about 7 in. or 8 in. Crushed gravel will pack quicker than natural gravel and consequently the compacted layer will be thinner. Where crushed stone was used the total thickness was 10 in. loose applied in two courses. The first course must not be less than 6 in. before compaction. That first course should be rolled first with a light roller of about eight tons, as a heavy roller will sink through the loose stone and sand. The filling of the voids is done in the ordinary way, and the stone is bonded by sprinkling and rolling.

The total thickness of loose materials laid for foundation is about 18 in. which reduces to about 15 in. after compaction.

In the case of concrete pavement, the concrete is laid directly over the sand cushion and no additional foundation is necessary. Care must be taken to wet the sand thoroughly to avoid absorption of concrete water or grout by the sand. Steel forms are supported by wooden posts driven in the subgrade to the proper elevation.

When the sand cushion is laid on the whole width of the road-bed, gravel or crushed stone shoulders must be built up and compacted to some consistency in order that they may eventually carry the traffic without danger.

The description of the method employed to build up foundations for permanent roads in Quebec Province implies no rigid principle and is not given as a final solution. Further experimenting is necessary and more study of soil conditions would certainly result in savings.

OVER $1,000,000,000 MOTOR VEHICLE TAXES PAID IN 1932

DURING the summer of 1933 a survey was inaugurated by the Bureau of Public Roads for the purpose of determining the total of all special taxes imposed on the owners of motor vehicles in the United States. The calendar year 1932 was the most recent year which could be studied. A large volume of data was gathered and the work of analysis was not completed until the summer of 1934. The present survey, which was carried out under the joint supervision of H. S. Fairbank, Chief of the Division of Information, and E. W. James, Chief of the Division of Highway Transport, is the broadest in scope yet attempted, as it includes not only state taxes but also federal excise taxes, county and municipal taxes, personal-property taxes on motor vehicles imposed by state, county and municipal jurisdictions and public bridge tolls. Only the public charges borne directly by the motor vehicle owners were included in the survey.

Purposely excluded from the investigation were such indirect charges as automobile dealers' license fees, fines and penalties, real-property taxes on automotive property (factories, garages, truck and bus terminals, etc.), income taxes on motor-vehicle operating enterprises, state chain-store and retail-sales taxes applying to gasoline stations and dealers in automobiles and automotive equipment, and similar imposts which are not levied directly on the ownership and operation of motor vehicles. A full report of the investigation is in course of publication but will not be available in the immediate future. However, a digest of the essential information produced by the survey is given by G. P. St. Clair, Associate Highway Engineer in Public Roads. Table I gives the total number of vehicles of each type and class of service reported in the survey as registered and paying regular fees in 1932, together with corresponding payments of registration and special fees, and estimated gasoline tax payments. Publicly owned and tax-exempt vehicles, where separately reported, were excluded from the tabulation.

It was found that the owners of passenger cars, which constituted 84.3 per cent of all vehicles, paid 72.9 per cent of the registration fees and 73.1 per cent of the gasoline taxes.

Taxicabs, reported separately from passenger cars in 27 states and the District of Columbia, comprised 0.3 per cent of the vehicles; they contributed 0.5 per cent of the registration fees and 0.9 per cent of the gasoline taxes.

TABLE I—REGISTRATION AND TAXATION OF MOTOR VEHICLES IN 1932

STATE FEES AND TAXES

Registration:	Vehicles registered and tax-paid	Registration fees paid
Passenger cars, including taxicabs	20,836,362	$214,725,478
Busses	49,452	3,416,697
Trucks and tractor trucks	3,229,315	71,204,768
Trailers and semitrailers	415,276	3,515,345
Motorcycles	89,197	326,889
Total	24,619,602	$293,189,177
Special motor-vehicle carrier fees		5,230,792
State gasoline taxes		513,047,239
Operators' and chauffeurs' licenses		18,280,802
Miscellaneous fees and taxes		9,082,968
All State fees and taxes		$838,830,978

ALL FEES AND TAXES

Federal manufacturers' excise taxes	$ 92,378,000
State fees and taxes	838,831,000
County fees and taxes (incomplete)	1,703,000
Municipal fees and taxes (incomplete)	14,158,000
Personal property taxes, all jurisdictions (approximate)	35,880,000
Public bridge and ferry tolls (incomplete)	18,200,000
Grand total	$1,001,150,000

Motor busses, which included 0.2 per cent of the vehicles, contributed 1.2 per cent of the registration-fee payments and 1.2 per cent of the gasoline taxes.

Motor trucks and tractor trucks, comprising 13.1 per cent of the vehicles, paid 24.2 per cent of the registration fees and 24.7 per cent of the gasoline taxes.

Trailers and semitrailers constituted 1.7 per cent of the vehicles and paid 1.2 per cent of the registration fees.

Motorcycles, constituting 0.4 per cent of the vehicles, contributed 0.1 per cent of the registration fees and 0.1 per cent of the gasoline taxes.

Conclusions and Comments.—The complexity of the motor-vehicle tax situation in the United States makes it very difficult to draw any conclusions which are both definite and generally applicable. The following statements, however, are supported by the data gathered in this survey.

1. There is an extraordinary lack of uniformity among the states, both in the methods of motor-vehicle taxation and in the magnitudes of the rates charged. The greatest variation was found in the basis on which registration fees were charged, including gross weight, net weight, chassis weight, capacity, horsepower, value, and various combinations of these factors. The gen-

eral adoption of a common basis for registration fees is desirable.

2. The principle that registration fees should increase with the size of the vehicle, as measured by weight, carrying capacity, horsepower, or cost, is recognized in the laws of all States, the only exception being the District of Columbia, in which a uniform fee of $1 is charged. There is great variety in the application of this principle; in some States the increase of registration fees with size is relatively moderate, while in a few the range is very wide, registration fees in excess of $1,000 being charged against the heaviest vehicles.

3. There is a noticeable tendency for the taxation imposed on motor vehicles to be relatively high in those States in which the intensity of motor-vehicle ownership is low, as indicated by a relatively large number of persons per vehicle. This condition was particularly noted in the Southern States, where the mileage of roads to be improved and maintained is very large in relation to the number of motor vehicles registered.

4. The imposition of unusually high registration fees on heavy vehicles, particularly trucks, in a few States, combined with high gasoline taxes, has apparently discouraged the registration of such vehicles, with the result that the high rates were productive of little revenue in 1932.

5. Comparison of the number of heavy trucks registered in certain States with the existing mileage of high-type roads and particularly of portland cement concrete roads, in the same States, leads to the conclusion that such roads have been built primarily in response to the demands of traffic in general, rather than specifically to support heavy loads.

6. Approximately 9 per cent of the revenues derived from State motor-vehicle and gasoline taxes in 1932 were diverted to uses not related to roads and streets. The principal items of diversion included payments to general funds, $39,652,339; unemployment relief, $19,546,456; and schools, $14,522,113.

7. Fees and taxes imposed on motor vehicles by counties in 1932 were negligible in comparison with those imposed by other jurisdictions, the total reported being less than $2,000,000. Such taxes were found in only 5 States. Fees imposed by municipalities were found in 39 States, and the total amount reported was over $14,000,000.

8. Personal-property taxes were imposed on motor vehicles by either State, county, or local authorities in 31 States and the District of Columbia, the estimated collections being in the neighborhood of $36,000,000. Because of difficulties in assessment and collection the personal-property tax as ordinarily administered is not effectively applied to motor vehicles. Five States and the District of Columbia require that evidence of tax payment be presented before licenses are issued to vehicle owners, thus insuring full collection for all registered vehicles. Seventeen States, containing 46 per cent of all registrations, exempted motor vehicles from taxation as personal property.

1933 *Registrations and Payments Compared With Those of* 1932.—In Table II a comparison is made between the payments by motor vehicles in 1932, as given by the survey (plus certain other items) and the data on State motor-vehicle and gasoline taxes for 1933, given in the annual tables published by the Bureau, together with the 1933 payments of Federal excise taxes relating to motor vehicles. No data were obtained on payments in 1933 of county and municipal fees and taxes, personal-property taxes or public bridge tolls, and for this reason no total is given for 1933.

TABLE II—COMPARISON OF MOTOR-VEHICLE TAX PAYMENTS IN 1932 AND 1933

Item	1932	1933	Increase or decrease in 1933
Vehicles registered:			
Passenger vehicles[1]	20,885,814	20,600,543	—285,271
Trucks and tractor trucks.	3,229,315	[2]3,226,747	—2,568
Trailers and semitrailers..	415,276	472,789	+57,513
Motorcycles	89,197	91,987	+2,790
All vehicles	24,619,602	24,392,066	—227,536
Registration fees:[3]			
Passenger vehicles[1]	$218,907,499	$195,841,695	—$23,065,804
Trucks and tractor trucks.	71,444,038	[2]70,298,260	—1,145,778
Trailers and semitrailers..	3,682,872	4,298,007	+615,135
Motorcycles	326,889	320,853	—6,036
All vehicles	$294,361,298	$270,758,815	—$23,602,483
Special taxes paid by commercial carriers[4]	4,058,671	5,398,154	+1,339,483
Operators' and chauffeurs' licenses	18,280,802	18,075,282	—205,520
Certificates of title	4,340,239	3,507,984	—832,255
Dealers' licenses and plates[5]	1,913,977	1,596,647	—317,330
Miscellaneous fees:			
Included in 1932 survey	4,742,729	8,755,337	+992,151
Not included in 1932 survey	3,020,457		
State gasoline taxes[6]	514,138,900	519,403,456	+5,264,550
All State fees and taxes..	$844,857,073	$827,495,669	—$17,361,404
County fees and taxes (incomplete)	1,703,455	.....	.....
Municipal fees and taxes (incomplete)	14,157,822	.....	.....
Personal-property taxes (estimated)	35,880,000	.....	.....
Federal excise taxes[7]	92,377,998	244,825,000	+152,447,002
Public-bridge and ferry tolls (incomplete)	18,199,424	.....	.....
All fees and taxes	$1,007,175,772	.....	+$135,085,598

[1]Includes private passenger cars, taxicabs and other cars for hire, and busses.

[2]Busses registered with trucks in eight States.

[3]Includes special fees (receipts taxes, ton-mile taxes, and passenger-mile taxes) paid by common-carrier trucks and trailers and public-carrier busses in lieu of registration fees. Amounts: In 1932, $1,172,121 paid in California, Maryland, South Carolina and West Virginia; in 1933, $1,033,931 paid in California, Maryland and South Carolina.

[4]Special taxes paid in lieu of registration fees deducted. The 1933 figures are incomplete, as a number of States imposing special taxes failed to report them.

[5]Not included in 1932 survey total.

[6]Includes item "other receipts under tax law," $1,091,661 in 1932 and $1,207,738 in 1933. This item was not included in the 1932 survey total.

[7]Includes Federal excise taxes on gasoline, lubricating oil, tires and inner tubes, automobiles, motorcycles and trucks, and parts and accessories. Deductions made to allow for power motor-vehicle use of gasoline and oil.

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First Aid Stations on Roads in France.—First aid stations for use in case of accidents have been installed on most of the roads of France by the National Union of Tourists Association. These posts, indicated by means of a plaque with blue background bearing the red cross on white (Geneva cross) are in direct telephonic communication with doctors or the nearest sanitary organizations. The expenses of installation, upkeep, supervision and supply of these posts are covered by donations and by contributions from the various tourist organizations.

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Purdue Road School.—The 21st annual Road School will be held Jan. 21-25 at Purdue University, Lafayette, Ind. The general sessions will be held in the civil engineering building of Purdue and the exhibit of materials and equipment will be held in the Purdue Armory, as in previous years. About half of the schedule time will be devoted to separate sessions of the various cooperating groups.

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Logs Used for Stiffener Trusses on Suspension Bridge.—A bridge built last year over the Clackamos River in the U. S. Mt. Hood Forest by CCC forces consists of short framed-bent approaches leading to a 243 ft. cable suspension span. The cable towers, rising from concrete piers, are of pressure-treated creosoted Douglas fir, as are the floor beams, stringers, and floor system bracing. The rest of the bridge, including the approach span, is of untreated Douglas fir. A novel feature of the bridge is the use of four 65 ft. logs on each side of the suspension span, strapped to the floor beams and taking the place of the usual stiffener trusses.

NEW DEVELOPMENTS IN THE ART OF STREET LIGHTING

THE development of the sodium-vapor lamp described in the report of the ASME Committee on Street and Traffic Lighting last year and the equipment required for its use in the field of street lighting has now advanced to the point in this country where considerable public and official interest has been aroused in its possibilities and application. European practice in the use of gaseous-conductor lamps is somewhat in advance of that of the United States and many interesting installations may be observed throughout the continent.

Manufacturers report that a fairly large number of trial installations have been put on demonstration in various parts of this country and others have been put into actual street lighting service. While it is true that this light source is new within the past two or three years and of course subject to future development, particularly in its lumen output efficiency and service life as laboratory research progresses, in its present form it seems to be functioning very well.

Is Especially Applicable to Highway Lighting.—From the observations and studies that have been afforded by the installations now in service in the field of street lighting practice, the sodium-vapor lamp seems especially applicable to highway illumination, where the effects produced by the monochromatic orange-yellow color of the light source appears to be of much less importance than on urban streets.

Present demonstrations of the sodium-vapor unit, particularly in the eastern states, are largely on interurban and rural highways. This lamp is now being made in 4,000, 6,000 and 10,000 lumen sizes. Fixture equipment has been especially designed to conform to highway lighting requirements.

Mercury-Vapor Lamp for Street Lighting.—During the past year another gaseous-conductor light source, designed for street lighting service, has been placed on public demonstration. This is the high pressure mercury-vapor lamp. The general principles of design and operation are quite similar to the sodium-vapor lamp, except in the color of the light produced. In contrast to the monochromatic golden-yellow color of the sodium-vapor lamp, the mercury-vapor lamp emits a light which has predominately a blue-green color, with a complete absence of all wave lengths in the red bands of the spectrum. It is possible to correct this deficiency in the mercury-vapor light through a combination with the light from a tungsten filament incandescent lamp and obtain a whiter light than that now furnished by present street lighting lamps.

Mercury-vapor lamps heretofore employed in the field of industrial lighting have operated at relatively low gaseous pressures generating their light output at 10 to 12 lumens per watt of electric energy consumed. Through research and experiment, it was found that by operating the gas at considerably higher pressures, approximately that of one atmosphere, much higher luminous efficiency could be attained. The new high intensity mercury lamp designed for street lighting use is operated at this higher pressure.

This lamp is made up in tubular bulb form and employs a screw socket like the ordinary filament lamp. The bulb actually consists of two tubes, one within the other, the space between the two being evacuated in order to minimize heat losses. At each end of the inner bulb, a double electrode is provided, the arc being established between the two pairs of electrodes. When first turned on, the lamp glows for a few seconds with a ghostly glow afforded by argon gas which first establishes the arc. Then, after a few seconds, as the liquid mercury begins to vaporize, the characteristic blue-green glow of mercury, but of rather low intensity, is shown. Then, over a period of approximately 10 minutes, the lamp grows brighter as more and more mercury is vaporized and serves to establish a stronger, more intense arc. When the lamp stabilizes at operating conditions after 10 minutes to 15 minutes of service, the light is chiefly emitted by an arc stream of incandescent mercury gas at the center of the bulb.

What the future possibilities may be for the gaseous-conductor light sources in the art of street lighting can not be foretold at this time because these lamps, the equipment required for their use, and their field of application are still in the stages of development and demonstration. However, at this time, it is believed that the sodium-vapor lamp is particularly useful in highway lighting and the mercury-vapor lamp to "White Way" lighting on business streets perhaps in combination luminaries employing both mercury-vapor and incandescent lamps.

The principal advantage claimed for the gaseous-conductor lamp over the tungsten filament incandescent lamp, is the much higher luminous efficiency per unit of energy consumed. At present, due to the limited production of lamps, equipment and lack of operating experience, costs are high and offset savings in power consumption. With quantity production, cost of both lamps and equipment will be materially reduced and the use of gaseous-vapor lamps for street lighting, where this light source is particularly adaptable, will undoubtedly increase.

New Multiple and Series Street Lighting Lamps.—

During the past year the incandescent lamp manufacturers have announced a new line of multiple lamps specially designed for street lighting service. The most significant change in these lamps is that their average rated life is 1,500 lamps, in comparison with the average rated life of 1,000 hours for the general service multiple lamps.

A new line of series street lighting lamps, known as the "group replacement" line has also been announced by lamp manufacturers. The smaller lamps in this line have a longer rated life, thereby giving in effect a greater "factor of safety" against burnout of these lamps between the group replacements. This greater "factor of safety" against burnout is desirable because the smaller lamps are for the most part in the outlying districts where patrolling is less frequent and where the cost of emergency replacements is higher.

Illuminating Engineering Society.—The Committee on Street Lighting of the Illuminating Engineering Society, on which this society is represented by the chairman and several other members of the Committee on Street and Traffic Lighting of this society, has several studies and investigations of importance in the art of street lighting under way but incompleted at this time. Of particular interest to the members of this society is the study of the reflection characteristics of different colored street pavements mentioned in the first part of this report, revision of the "Code of Street Lighting" and an investigation of the dispersing power characteristics of white glass diffusing globes for street lighting use. Unfortunately none of these studies could be completed so that this committee could report on them this year. We recommend these subjects for consideration to the future Committee on Street and Traffic Lighting.

The foregoing is an abstract of a report of the Committee on Street and Traffic Lighting of the American Society of Municipal Engineers presented at the Congress of the Society, held Sept. 24 to 28 at Rochester, N. Y. The members of the committee are: A. B. Barrett, M. T. Ducros, T. M. Matson, D. C. Meyers, G. H. Nye, K. M. Reid, F. J. Von Zuben, L. A. S. Wood, W. T. Blackwell, E. Francisco, Chairman.

The committee intended to discuss the reflection characteristic of different types of street pavements in its report this year and to embody in it the results of the investigation which the Street Lighting Committee of the Illuminating Engineering Society had started early in the year. As the investigation progressed, it was found that a great deal of research would be necessary, and too late for the A. S. M. E. Committee to select another subject for its report, it was determined that considerably more time than the members of either committee could devote this year, would be required to finish this work. Therefore, the committee reported on some of the new developments in the art of street lighting.

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Removing Surplus Filler from Brick Pavement —An ingenious method of removing the surplus asphalt filler from a newly laid brick pavement was used on the new "Sunset Boulevard" in Steubenville, O. Before applying the asphalt a light coating of a solution of lime and water was sprayed on the surface of the brick. The asphalt was then applied. The solution prevented the asphalt from adhering to the top of the brick and the excess asphalt was readily removed, and the finished pavement presents a clean brick surface. This gives immediate effect to the benefit of the rough or wire cut brick surface without the necessity of waiting for the surplus asphalt to be worn off by traffic.

Photo Copyright White Mt Studios

Rotary Plow of New Hampshire State Highway Department Keeping Open Last Winter the Roadway Through Franconia Notch in the White Mountains

TWO IMPORTANT WEATHER CYCLES

By HALBERT P. GILLETTE

WHEN De Soto was exploring the Mississippi he saw an enormous flood in March, 1543. Indians told him that such floods came every 14 years. There is a rain cycle slightly longer than 14 years, but its amplitude is too small to explain a flood as great as that witnessed by De Soto. There is a cycle of about 153 years, whose amplitude is greater than that of any cycle langer than 10 years, with the exception of a cycle of about 53 years. A peak of the 153-year cycle was due in the Mississippi Valley about 1543.

An Australian civil engineer, Keele, in 1910, found excellent evidence of this long cycle in the flood levels of the Nile. He had Nile flood data covering only two centuries, and therefore could not determine its length with accuracy. He made it 171 years, but was apparently led to adopt this figure because he thought the cycle was harmonic with the 19-year Australian cycle discovered by Lockyer. He called the shorter cycle $3x19 = 57$ years, whereas it is really only slightly more than 53. And he called the long cycle $3x57 = 171$ years. Although some cycles are nearly harmonic, the writer has found none that are exactly so.

In 1914 Huntington found a cycle of 155 years in tree rings using data between 1400 and 1900 A. D. He did not err by more than 1%, although his data covered only three cycles. The writer has used California sequoia rings, measured by Douglas, covering 3,000 years, and finds the cycle to be 153 years.

In 1923 Prof. Charles F. Marvin published an analysis of New England rainfall using a method that he called "the accumulated sums of departures from the annual mean." The method is identical with that used by Keele in studying the Nile floods. Keele called it "the residual mass diagram method." Neither Marvin nor Huntington mention Keele's research, which is not surprising since it was published in the transactions of an Australian society. Nor does Marvin mention Huntington's cycle of 155 years, although Marvin's curve clearly indicates a cycle of about that length. His curve also indicates a cycle of about one-third that length.

Not until the writer read of the discovery by Antevs of a cycle of the order of 55 years in the spacing of 11 glacial moraines in the Connecticut River Valley, was he sufficiently impressed with the importance of this cycle to undertake to determine its length with exactitude by means of tree-ring data. In a later article the results of this investigation will be given. A rain peak of the 53-year cycle in the Arizona pines was about 1872. Hence a rain valley will occur not far from 1951. A rain valley of the 153-year cycle will occur within 10 years. The northern central states will be dry for more than 20 years. There will be occasional years of normal or possibly supernormal rainfall, because there are at least 6 other cycles of importance. Although the other cycles have amplitudes half as great as those of the 53 and 153-year cycles, the combination of two or more of their peaks causes brief periods of heavy rainfall.

There are only three kinds of data that can be used in determining the lengths of long cycles with accuracy, namely: First, the records of Nile River floods and low levels which date back to 622 A. D., but have several breaks so long as to leave only about 1,000 years of data; second, the sequoia tree-ring measurements by Douglass and by Huntington, covering more than 3,000 years, together with the Douglass measurements of the Arizona pines; and, third, the measurements of annual laminae, or varvs, in ancient lakes. De Geer has a continuous record covering nearly 18,000 years in Europe but has published no record longer than 700 successive years. Antevs has published his measurements of ancient glacial lake varves in the Connecticut River Valley and to the north, covering about 6,000 years, but there are breaks in the record, leaving about 2,400 years as the longest unbroken series of annual varves. The varves show the same cycles that the tree-rings and the Nile floods show. Hence there can be no doubt of their value in determining the lengths of long cycles. Antevs speaks of the readvance of the ice front after an interval of about 1,700 years, which seems to indicate a cycle of about that length, but it may indicate the combined effect of several cycle peaks.

Bradley's discovery of a climatic cycle of the order of 25,000 years in the varved oil shales and marlestones of Colorado is one of the greatest of discoveries bearing upon meteorology, but no mention of it has appeared as yet in any meteorological publication. This arises from the fact that discoveries in the realm of geology are usually slow in reaching the eyes of meteorologists. The discoveries of the Swedish geologists, De Geer, and Antevs are still not well-known to most meteorologists.

Accurate long-range weather forecasting will be impossible unless there are long cycles and unless all those of large amplitude are known. Fortunately, the number of these appears to be fewer than a dozen, of which the two above mentioned account for nearly all the long dry and wet periods having a duration of more than 10 and less than 30 years.

The Bradley climatic cycle is apparently due to the magnetic fields of the earth and sun, for about every 12,800 years the earth's axis and that of the sun would have the same heliocentric longitude, if the sun's axis gyrates very slowly; and during the winters every 25,600 years, terrestrial electron shells would be so greatly depressed by magnetic action as to cause very abnormal currents of electrons in the air. The last peak of this cycle was about 16,000 B. C., or about the date assigned by De Geer to the crest of the Ice Age. About 12,800 years later (3,200 B. C.), the summers should have been wet and cool, and the winters dry and warm. There is historical evidence of a wet period about then.

All cycles that the writer has investigated have opposite phases in summer and winter. There is good evidence of a similar opposition in spring and fall. The result is that each cycle has four distinct peaks, one in the spring, followed by one in the winter, then one in the fall, and one in the summer, the dates of these peaks being separated by one-quarter the length of the cycle. This is explainable if terrestrial gyrating electron shells cause cycles and if the gyration of the north pole of the axis of the shell is clockwise. Where annual rainfall, and not seasonal rainfall, is used in searching for cycles, it follows that a cycle one-quarter the length of the basic cycle will be found wherever rainfall exists in considerable quantity throughout the year.

Thus Alter found a cycle of about 2.5 years in European rainfall, whereas the cycle is 10 years in sequoia ring thickness, because there is only one season of precipitation in California.

EDITORIALS

Weather Forecasting by Cycles

THE ancient Egyptians built the "Nileometer," which is a well, near the bank of the Nile, in which is a gage for measuring the level of the river. C. E. P. Brooks, in "Climate Through the Ages," says that records of high and low water were probably kept by the Egyptians for hundreds of years before the birth of Christ, but none are available prior to 622 A. D. At that time the Turks, who had conquered Egypt, began to keep records of Nile flood and low levels, and there is available an almost continuous record for about eight centuries. Then long gaps occur in the record until 1736 A. D.

Why did the Egyptians keep these records? It has been suggested that tolls for the use of water for irrigation may have been charged, and that this led to measuring the river runoff. It is difficult to see why the river level should affect the rates charged for the use of its water, except perhaps in periods of drought. On the other hand the Egyptians were pioneers in the study of astronomy and were likely to have regarded the planets as affecting the weather by virtue of their periodical changes in position. If so the "Nileometer" was probably man's first measuring device having as its object the forecasting of rainfall by means of cycles.

When Joseph predicted "seven fat years" to be followed by "seven lean years," he was apparently using a 14-year cycle. It may be more than a coincidence that American Indians told De Soto in 1543 that floods of the Mississippi occur every 14 years. At any rate, a 14-year weather cycle is the earliest one suggested either in sacred or profane literature, with the possible exception of an alleged 35-year cycle mentioned by Sir Francis Bacon.

Not until after the discovery of the so-called 11-year sunspot cycle by Schwabe, about a century ago, did modern scientists seriously undertake to find weather cycles. During the past 30 years the search for cycles has increased greatly in scope and intensity, yet the number of men thus engaged has been amazingly few. The fingers of one's two hands would probably serve to tally all the weather cycle researchers who have each devoted the equivalent of more than three years to continuous cycle research.

The time is not far distant when men will marvel at the present and past apathy about weather cycle investigation. Agriculture can never be conducted in a highly scientific manner until accurate long-range weather forecasting is an accomplished fact. Water supply for cities and power stations will usually remain uncertain until that same goal is reached. Since billions of dollars of farm products are annually at the mercy of the weather surely no sum expended upon weather cycle research should be regarded as excessive.

Secretary of Agriculture Wallace recently announced the employment of Larry Page as a weather researcher. He said that although the odds might be 10 to 1 against a successful issue of Mr. Page's investigations, his employment was justified. By the same reasoning the employment of hundreds of other weather researchers is justified.

Should it seem doubtful whether many cycle researchers could be wisely employed, let it be remembered that the measurement of tree-rings alone would keep scores of men busy for years. Only in California and Arizona has that sort of measurement covered a span of more than 500 years. The cedars of Labanon, as Huntington pointed out, should be measured at once. There are sequoia logs buried in the mud of the Sacramento River that probably would enable a researcher to carry tree-ring measurements back fully 3,000 years prior to the earliest measurement made by Douglass or Huntington. The Douglass measurements of living sequoias start about 1500 B. C. They form a priceless weather gage of annual precipitation in central California. Yet even those measurements do not cover a long enough period to permit a determination of the existence of cycles exceeding about 500 years in length.

Another sort of weather gage provided by Nature consists of the annual laminae, or varves, deposited in ancient and modern lakes. Only a bare beginning has been made in measuring varved clays, shales, etc. Yet the cause of the Ice Age cycle and shorter climatic cycle, like the Bradley cycle, can be fully established only by measuring varves. In another article in this issue the length and cause of the Bradley cycle are briefly discussed. In that article cycles of 53 and 153 years are also discussed. In later issues evidences as to each of the following cycles will be presented: 2.03, 10.02, 14.3, 16.6, 18.85, 23.85 and 70 years. The amplitudes of these cycles average considerably less than those of the 53 and 153-year cycles. Nevertheless they are all important factors. There may be other long cycles equally important, but it is a very slow and laborious job to analyze the sequoia tree-rings for 3,000 years so carefully as to permit no important cycle to escape discovery.

The parallel column method of cycle analysis in its original form was first suggested by Balfour Stewart nearly 50 years ago. In its improved forms it is the best method of discovering cycles where their lengths and amplitudes do not differ greatly. The "accumulated sums of departure method" is of use only where the cycles are quite long and of unusually great amplitude. The technique of cycle analysis is now satisfactorily developed. It remains only to apply it, and to gather more tree-ring and varve data for scientific analysis.

The writer has spent the equivalent of seven years of continuous research in this field, and fully realizes the need of more data and more analyses of data. It is that experience that leads him to urge the employment of hundreds of data and cycle researchers by our government.

There are regional differences in rainfall that are still so puzzling that no slight amount of research will be required before they will be fully understood. Relative distances from a "permanent" cyclone or anticyclone often seem to explain such differences, but at times they do not. Shifting of storm tracks from their usual courses is another puzzling phenomenon whose solution will be necessary before accurate forecasting for each region will be possible.

The whole problem of weather forecasting bristles with difficulties that spring from our ignorance of at least some of the causes involved. But the time has come when governments should engage researchers to investigate thoroughly every hypothesis that is even plausible.

COUNTY AND TOWNSHIP ROADS

A Section Devoted to Those Interested In Secondary Road Improvement

THE ORIGIN AND ROAD BUILDING PROPERTIES OF SHALE

By D. G. RUNNER

Assistant Materials Engineer, U. S. Bureau of Public Roads

IN RECENT years many state highway departments have investigated various types of materials for use in building low-cost roads. Certain varieties of shale have been found to possess suitable qualities for this type of construction. Such shale roads have proved to be economical and to provide good riding qualities, and in addition the roadway can be maintained at reasonable cost and later improved by the progressive or stage construction method to serve increased volume of traffic. Several states, among which are Virginia, West Virginia, Pennsylvania, and Wisconsin, have developed methods of utilizing shale in the construction of their highways. It has been reported that this type of surfacing has produced good riding qualities as well as excellent service. It is the purpose of this paper to present some information relative to the origin and composition of shale, together with data pertaining to the use and suitability of this material, as determined by laboratory methods, for road surfacing purposes. Numerous publications have been drawn upon for information bearing on this subject and these are given in the foot notes as well as the appended bibliography.

The Origin and Composition of Shale

According to Clarke[1] shale is supposed to be a consolidated mud or clay in which the aluminous silicates are the most important and characteristic constituents. Shales vary in their composition in conformity with the materials from which they are derived and quite often contain large amounts of sandy or calcareous minerals. The colloidal matter contained in most muds and clays has the property of binding under the influence of pressure alone. Physically shales are soft and fragile, may be readily cut with a knife, and invariably have a very perceptible cleavage. They may grade into clay by an increase in the plasticity, or into sandstone by an increase in the amount and size of the quartz grains. Correspondingly there are a great many varieties and colors of shale, chief among which are the following: gray shales characterized by a high quartz and/or high lime content, carbonaceous shales containing carbon or hydrocarbon in quantities sufficient to produce a dark color, ferruginous shales with an iron content producing yellow, red or brown color, and green shales containing glauconite.[2] In general the color of the clay or shale deposit is dependent upon the nature of the parent or original rock. For example, if the original rock contained no iron or other color producing minerals the chances are that the resultant clay would be white or

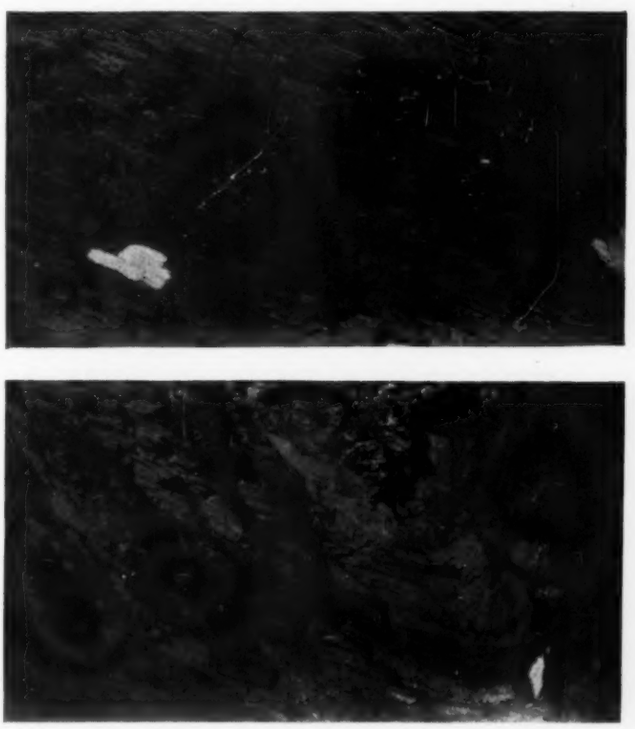


Fig. 1.—(A, Top) Inclined Shale Bed Showing Parallel Bedding. (B) Shale Bed Distorted by Earth Movements. Both Photos Secured on U. S. Route 50.

[1]Data of Geochemistry, F. W. Clarke, Bulletin 770, United States Geological Survey, 1924.

[2]A dull green amorphous hydrated silicate of ferric and potassium iron.

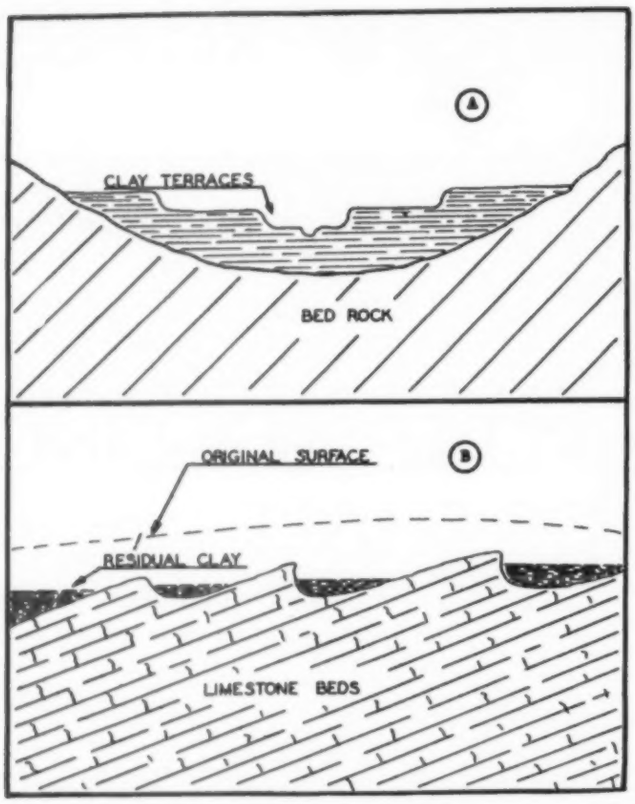


Fig. 2—(A) Profile of Clay Terraces Formed by Stream Action, Transported Clay. (B) Residual Clays Formed from Limestone

nearly so, while on the other hand if iron was present the material would have a reddish or brownish cast.

Chemically the formation of clays and shales is brought about by the weathering and alteration of the silicate minerals which go to make up the rocks of the earth's crust. The chief silicate minerals are orthoclase, anorthite, albite, biotite, muscovite, augite and hornblende. One of the most important of these rock-making minerals is orthoclase feldspar, a mineral which is readily attacked by waters containing carbon dioxide in solution. During this process the following reaction takes place:

(Ortho-clase) (Kaolin) (Potassium carbonate)

$$2KAlSi_3O_8 + 2H_2O + CO_2 = H_4Al_2Si_2O_9 + 4SiO_2 + K_2CO_3$$

Thus kaolin, the chief clay mineral, and related products are formed by the weathering of rock silicate minerals. Naturally the remaining silicate minerals noted above react in a similar manner to form clay-like products.

Primarily shale has its origin in the extremely fine-grained, decomposed material derived from ingeous and other rock types, the finer particles being deposited "in situ" or transported and then deposited by stream or ice action. These depositions have taken place along stream banks, in flood plains, and upon lake and ocean bottoms. Figure 2-A illustrates clay terraces along stream banks formed by transported material. In general there are three chief classifications of this finely-divided material commonly called clay, namely: residual, transported and glacial. Residual clays are the product of rock decay produced by the natural agencies of weathering. This "rock rot" material remains or is left in place on the site of the parent rock, hence giving rise to the name residual. Clays of this class are generally derived from igneous rock or from clayey limestones, since these types of rock contain minerals readily acted upon by percolating waters containing carbon dioxide in solution. Figure 2-B shows the formation of residual clay from limestone beds. Transported clays are not essentially different from the residual variety, but have in addition been subjected to the action of transporting agencies and thereby removed from their original place of production to a new location. The agencies of transportation involved have been either running water, ice and/or air currents. Glacial clays, as the name implies, result from glacial action wherein both weathered and unweathered rock material accumulated beneath the ice body has been ground to a fine-grained impalpable mass and deposited at or near the marginal edge of the ice, where they may be subjected to additional change by weathering. Deposits of this kind occasionally contain fragments of pebbles, limestones, etc., and are abundant in the glaciated areas of the northern part of the United States. Table I illustrates the differences in the chemical composition of residual, transported and glacial clays. From the table it may be seen that the clay resulting from the decay of the granite is much higher in silica than that derived from the basic rock pyroxenite. This is because of the fact that basic rocks are originally low in silica and relatively high in iron, magnesia, etc. This

TABLE I—CHEMICAL ANALYSES OF RESIDUAL TRANSPORTED, AND GLACIAL CLAYS

	Residual			Transported		Glacial
	A	B	C	D	E	F
SiO_2	56.40	38.82	48.96	62.80	52.73	40.22
Al_2O_3	25.62	22.61	26.27	18.23	22.25	8.47
FeO	3.45	....	....	6.40	7.69	0.48
Fe_2O_3	....	13.33	10.53	....	....	2.83
CaO	0.37	6.13	0.24	0.88	1.48	15.65
MgO	0.98	9.52	1.02	1.58	3.20	7.80
K_2O	2.99	0.18	....	3.05	4.28	2.36
Na_2O	1.36	0.20	....	1.48	2.22	0.84
H_2O	9.18	9.21	9.47	4.39	4.91	1.95

Note: Residual and transported clay analyses from "Building Stones and Clays," by E. C. Eckle. Glacial clay analysis from "Data of Geochemistry," by F. W. Clarke.

A. Residual clay from granite.
B. Residual clay from pyroxenite.
C. Residual clay from limestone.
D. Marine clay, Maine.
E. Stream clay, Connecticut.
F. Glacial clay, Wisconsin.

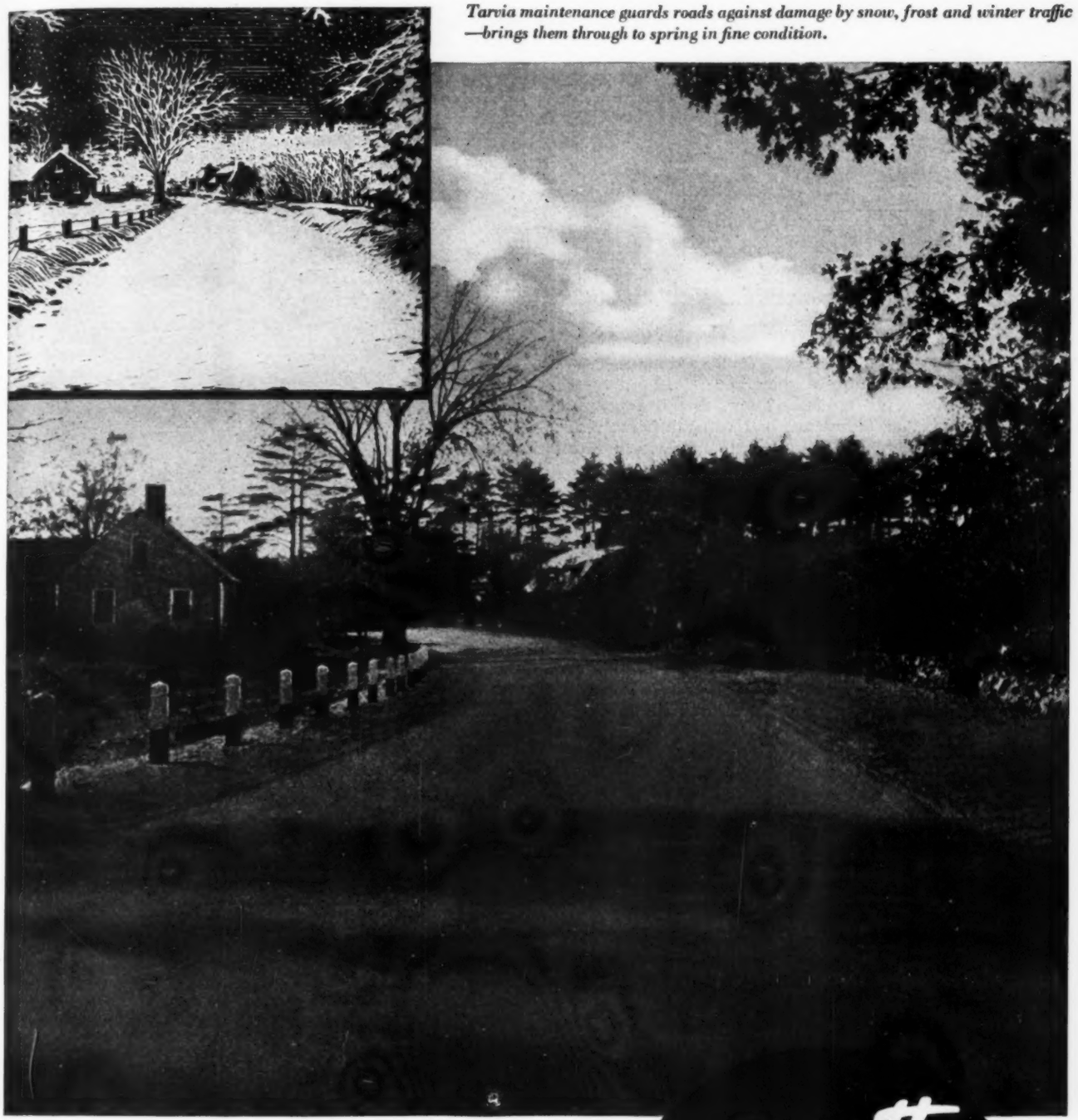
feature is brought out in the analyses. The analysis of the glacial clay indicates that the rock material was finely ground by the ice movement and was protected somewhat from the carbonic acid of the atmosphere. This is reflected in the analysis by the amount of soluble material which had been retained in the clay. According to Clarke and Washington[3] the rocks of the earth's crust are 95 percent igneous and 5 percent sedimentary. Of the sedimentary class it is estimated that by weight, 82 percent is shale, 12 percent is sandstone, and 6 percent limestone. From these data it might be said that in general the clays have been derived from the igneous type of rock.

Concerning the grain size of silt and clay, Twenhofel[4] places the dividing line at 1/256 mm. (or approximately 0.0039 mm.) with silt above and clay below this limit. Watkins and Aaron[5] in discussing the texture indicating the size of the individual soil grains give the following ranges for the seven "separates":

[3]The Composition of the Earth's Crust, F. W. Clarke and H. S. Washington, Professional Paper 127, United States Geological survey, 1924.

[4]Treatise on Sedimentation, W. H. Twenhofel, Williams and Wilkins Company, Baltimore, 1932.

[5]The Soil Profile and the Subgrade Survey, W. I. Watkins and H. Aaron, Public Roads, vol. 12, no. 7, September, 1931.



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0.05 to 0.005 mm., silt.
Below 0.005 mm., clay.

Subsequent to its deposition the clay has been consolidated by the weight of overlying accumulated sediments which has imparted a bedding or parallel arrangement to the component particles which is commonly described as cleavage. This condition is evidenced in the ease of splitting by which shale is so easily identified. This process of consolidation which secured an intimate contact of the particles, increased the partial cementation of the component minerals. Figure 1-A illustrates this parallel bedding in shale deposits, while Fig. 1-B shows the result of the distortion of shale beds caused by earth movement. For centuries subsequent to the deposition of the clay material sediments had constantly accumulated so that eventually the weight involved induced compressive action accompanied, we may assume, by temperature changes resulting in a perceptible alteration in the material. It is not definitely known at what rate this change took place, but during the process there was crystallization, dehydration or loss of water, and further cementation of the constituents. Table II is given to show the differences in the chemical composition between composite analyses of clays, shales, and slates. Note that the water content has been considerably decreased in the slates, likewise the ferric oxide, and that the silica and alumina have undergone an increase during this change. The long continued effect of pressure has caused the shales to become more compact and to lose water, and ultimately to pass into slate.

Shale in Road Building

The use of shale as a highway construction material has been practiced for a number of years in various parts of the country. Several states, chiefly along the Appalachian Mountain System where good deposits of shale are found, have developed methods whereby shale is used to advantage to provide surfaces capable of sustaining a fairly large range, in both volume and character, of traffic. Shale, when applied as either a base or a surface course, is in effect a natural sand-clay mixture very much like those artificially prepared mixtures used perhaps more generally in the southern states than those of the north. In this connection McWhorter[6] holds the opinion that a sand-clay soil of mechanical composition to possess good stability should have from 10 to 18 percent clay, 5 to 15 percent silt with a total sand content of 65 to 80 percent. These percentages are not essentially different from those for shale as given in Conner's Low Cost Road Report, for the Highway Research Board, 1928. This report states that for analysis and service results Mr. Gray concludes "that a percentage of silica in excess of 55 is required, that the presence of iron oxide in excess of 4 percent is necessary and that the cementing quality of the material largely depends on this factor. When Al_2O_3 is present in excess of 20 percent by volume the surface tends to become very slippery when wet."

TABLE II—COMPOSITE ANALYSES OF CLAYS, SHALES, AND SLATES

	A	B	C
SiO_2	54.28	58.38	61.90
Al_2O_3	14.51	15.47	16.54
Fe_2O_3	6.25	4.03	2.73
FeO	0.77	2.46	3.63
CaO	5.04	3.12	1.07
MgO	2.99	2.45	2.99
Na_2O	1.21	1.31	2.57
H_2O	8.41	5.02	3.84
CO_2	3.53	2.64	0.59

Note: Analyses from "Data of Geochemistry, by F. W. Clarke. Only essential components given.
A. Average of 12 analyses of clays and soils.
B. Average of composite analyses of 78 shales.
C. Average of 22 analyses of slates.

Fig. 3.—A Deposit of Clay Found Along River Road Near Washington, D. C.

Extracts from State Specifications.—Below is given excerpts from the state standard specifications of Wisconsin and West Virginia for shale base course and shale surfacing respectively. These data are given to show how these highway departments utilize this type of material in highway construction. The Wisconsin specifications for shale base course follow:

Shale Base Course

Description: This item shall consist of a base course composed of a layer of compacted shale laid on an approved Subgrade and of a width and depth as shown on the plans or as specified in the Special Provisions.

Material: Shale shall be obtained from pits designated on the Plans or in the Special Provisions, and shall be of a quality satisfactory to the Engineer. The pit shall be stripped in a satisfactory manner from areas where material is being obtained. The shale shall be broken at the pit by means of a crusher, rolls or other satisfactory device, so that all material will pass a four (4) inch ring.

Construction Methods

Subgrade: (a) Trench Method. The subgrade shall be prepared by cutting a trench in the roadbed to the width and depth shown on the Plans. The material excavated in preparing the subgrade shall be used in constructing the shoulders. Immediately after the shale has been placed in the trench and spread properly, the shoulder material shall be brought in against the shale and the roadbed shaped to the required cross section.

(b) Feather Edge Method. The subgrade shall be prepared in accordance with the pertinent requirements of Section 20.

Placing: (a) The shale shall be placed on the prepared subgrade to the width and depth shown on the Plans. The contractor shall provide a satisfactory horse-drawn grader weighing not less than sixteen hundred (1600) pounds with an eight (8) foot blade, to be used at the point of dump to spread the shale to the required cross section and to aid in maintaining the subgrade immediately in advance of the placing of the surfacing.

(b) After the shale has been placed and shaped as specified above, the contractor shall blade, maintain and compact the material with a tractor-drawn ten (10) foot blade grader weighing not less than six thousand (6000) pounds. After one mile of shale base course has been placed, the large grader shall be operated continuously, or as directed by the Engineer, on the sur-

[6]Surface Treated Sand-Clay Roads in Georgia and Florida, B. P. McWhorter, Roads and Streets, vol. 70, No. 2, February, 1930.

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Fig. 4.—Surface Treated Shale Road Near Romney, W. Va. Note the Shale Bank from Which the Surfacing Material Was Obtained. (Photo courtesy of State Road Commission of West Virginia)

face, maintaining the same to a smooth, compact, even-riding surface, true to grade and cross section, until accepted.

(Note: The above specifications were taken from "Standard Specifications for Road and Bridge Construction," State Highway Commission of Wisconsin, 1931.)

The West Virginia specifications for shale surfacing is as follows:

SHALE SURFACING

Description: On a subgrade, prepared in accordance with these specifications, shall be constructed a one-course shale surface of the cross section, width and compacted thickness shown on the plans.

Materials: The shale rock shall be of a quality satisfactory to the Engineer, and no piece shall exceed three (3) inches in its greatest dimensions. It shall meet the requirements of the Special Shale Tests devised by the "Testing Laboratory."

Construction Methods: The shale shall be dumped from trucks or suitable spreader wagons, and spread so as to form a smooth surface. The material not meeting the above size requirements, shall be reduced to the proper dimensions by hand knapping or other means. The shale shall be compacted under travel, and shall be shaped while being compacted by the use of a blade grader, tooth harrow, planer or other suitable means. Ruts formed by hauling or travel shall be dragged full at least once each day. Holes which develop shall be filled by adding fresh material.

(Note: The above data was taken from "Standard Specifications for State Road Construction," the State Road Commission of West Virginia, 1933.)

The special shale tests[7] noted in the materials section of the above West Virginia specification consist of an "accelerated weathering test" and a "washing test." The former method consists essentially in subjecting 250 grams of oven dried shale, which had been previously crushed and screened to pass the ½-in. and be retained on the ¼-in. screen, to a 5 cycle and 10 cycle freezing and thawing test. At the end of the 5 cycle period the sample is dried, screened over the ¼-in. screen, reweighed and subjected to an additional 5 cycles. The amount passing the ¼-in. screen at the 5 cycle and the 10 cycle periods is considered to be a measure of the ability of the shale to withstand weathering.

The washing test consists in using a 500-gram sample of shale of the ½-in. to ¼-in. size prepared as in the accelerated weathering test, together with approximately 600 cc. of water, and revolving the resultant mixture 5000 times in an assay mill. The mixture is removed and washed as in the elutriation test for sand, dried and reweighed. The loss by washing is based on the original weight of shale used. The West Virginia report further states that from a large number of test determinations it has been found that a minimum loss of less than 8 percent in the accelerated weathering test indicates a weather resisting shale too hard for use as surfacing material. The results of the washing test, it is claimed, provide more reliable indication of the quality of the shale, a maximum loss of about 10 percent usually indicating a fair to very good quality shale, and a loss of less than 5 percent indicative of a very good quality shale. The data in Table III, taken from the same report, is given to show the correlation of the accelerated weathering and washing tests with the actual service records of various shales. Only enough values were chosen to illustrate the comparison between laboratory tests and service behavior of the shales in the field.

[7]The information relating to the special shale tests was taken from "A Preliminary Report on an Investigation of Shale Used in Road Surfacing Together with a Description of the Shale Horizon in the Eastern Portion of West Virginia," West Virginia State Road Commission.

TABLE III—COMPARISON OF FIELD RESULTS WITH LABORATORY TESTS ON SHALE

Test Number	Loss by washing Per Cent	Loss by accelerated weathering, 5 cycles—10 cycles Per Cent		Field Results
1.....	4.3	10.8	15.6	Very good
3.....	4.2	12.0	16.8	do
5.....	2.8	15.2	26.0	do
6.....	4.0	33.2	50.8	Good
8.....	6.3	14.4	20.0	do
10.....	7.1	15.2	28.0	do
12.....	8.2	50.8	57.2	do
13.....	9.5	13.6	21.2	Fair
15.....	6.0	22.0	32.0	do
17.....	3.4	16.8	26.4	do
18.....	22.4	37.6	60.6	Poor
21.....	12.4	35.9	49.6	do
23.....	11.2	36.2	61.8	do
26.....	2.2	8.0	8.9	Poor—too hard
28.....	2.1	4.8	7.5	do

Note: Data selected from "A Preliminary Report on an Investigation of Shale Used in Road Surfacing Together with a Description of the Shale Horizon in the Eastern Portion of West Virginia," by State Road Commission of West Virginia.

Fig. 5.—Completed Shale Surface Treated Road, with Surplus Cover Coat of Crushed Shale at Side of Road. (Photo Courtesy of State Road Commission of West Virginia)

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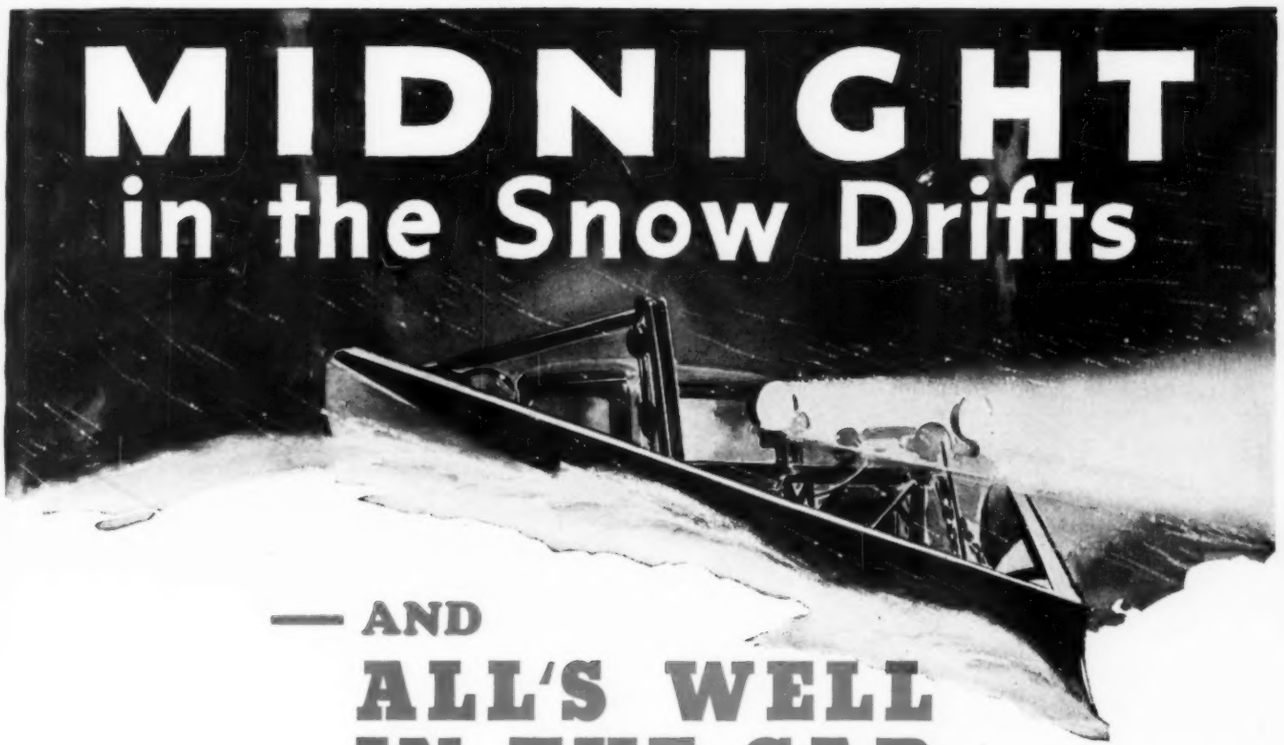

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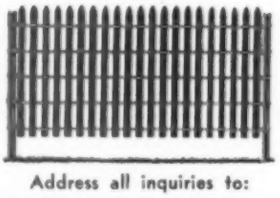

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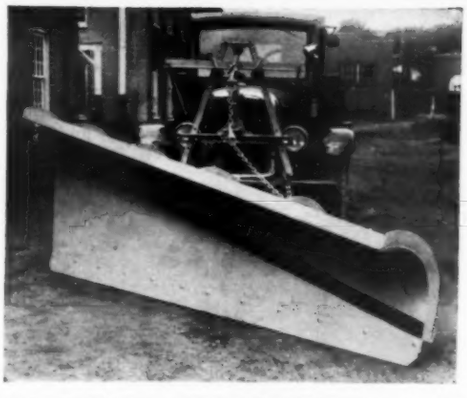

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The foregoing observations indicate the wide possibilities which are open for the use of shale roads, and that laboratory tests can be used to advantage to distinguish the better classes of this material. As stated previously shale abounds in most areas of the United States and is a potential source of surfacing material, especially for farm-to-market roads and for roads carrying a moderate amount of traffic.

[8]Personal communication from Mr. H. S. Mattimore, Engineer of Tests, Pennsylvania Department of Highways, Harrisburg.

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Code of fair competition, becoming effective Nov. 25, has been approved by the National Industrial Recovery Board, through executive order, for the bituminous road material distributing industry.

For purposes of administration, the United States is divided into nine regions, in any of which a regional Code Authority may be set up. A national Code Authority consisting of nine members, six of whom are to be members of the National Bituminous Road Material Distributing Associates and three non-members of the Association, is provided, with the prerogative of adding three non-voting Administration members. The Code Authority is empowered to fix a budget to cover expenses and establish a basis of contribution.

A basic 32-hour week is established, with a minimum wage rate of 40 ct. an hour in Kentucky, Tennessee, Alabama, Mississippi, Virginia, North Carolina, South Carolina, Georgia, Florida, Arkansas and Louisiana, and 50 ct. an hour elsewhere. Provision is made for overtime at the rate of one and one-half times a basic day scale of $6 for distributor-operators and $4.50 for distributor-laborers. No one under 18 except office boys, water boys or mess boys may be employed in the industry. Office workers are to be paid a minimum scale of $15 weekly. Persons receiving $35 a week or more are classed as executives and are not subject to the minimum wage and hour limitations.

Secret rebates, defamation, misbranding, misrepresentation, commercial bribery and lump sum bidding are defined as unfair trade practices. Open price filing is provided and wilfully destructive price cutting prohibited.

Scarcity of statistics has made an authentic analysis of the industry difficult, but the Code Authority committee ascertained that in 1933 there were 11,000 persons employed in the industry which had an invested capital of $35,000,000 and did $27,000,000 volume of business for that year.

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A New Use for a Concrete Finishing Machine

A Blaw-Knox electric road finisher equipped with special concave screeds and solid rubber-tired wheels is being used for finishing the invert in the Val Verde Tunnel now under construction for the City of Los Angeles Metropolitan Water Board by the Dravo Contracting Co. of Pittsburgh.

The specifications require that the invert of the tunnel be concreted last after the side walls and arch were concreted, and that the concrete be given a very smooth finish. This special type of Blaw-Knox electric finisher was designed to finish the invert.

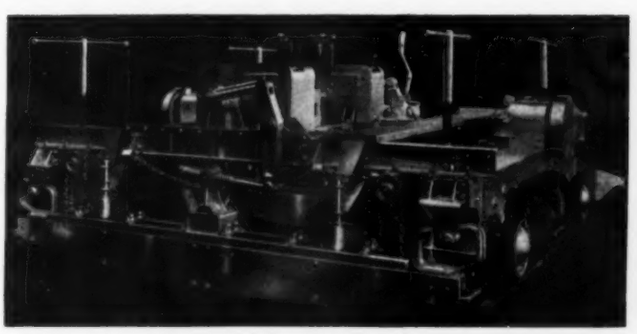
Traction and screeds are operated by electric motors. Power is furnished from a trolley in the tunnel.

To adapt the Blaw-Knox finisher for this work the following changes were necessary:

1. Special concave screeds to finish the tunnel invert.
2. The screeds were hung from the frame of the finisher so that they could function without the use of forms.
3. The machine was equipped with solid rubber-tired wheels to run on a narrow concrete ledge, which is integral with the side walls. The rubber tires were necessary to prevent fracture of the concrete ledge.
4. Precise steering by means of automatic brakes on the traction motors—one motor for each end truck. This was necessary because of the close operating clearances.

The finisher is equipped with the usual automatic screed lift and lowering (power operated) and spring shock absorbers for screed operation.

The finisher is used for both spreading and surfacing the concrete.



Road Finishing Machine Equipped for Work on Tunnel Invert

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INDIANA COUNTY COMMISSIONERS TO MEET.—The annual convention of the Indiana County Commissioners' Association will be held Nov. 22-23, at the Hotel Severin, in Indianapolis. The following committee chairmen have been entrusted with various phases of the convention plans.

Executive Committee, James A. Slane; Speakers' Committee, Roy Adams; Finance Committee, Bruce Short; Entertainment Committee, Charles Grossart.

View Taken in Goshen on Feb. 22 Showing the General Conditions in Massachusetts During the Past Winter.

EXTREME WEATHER CONDITIONS MAKE SNOW REMOVAL DIFFICULT

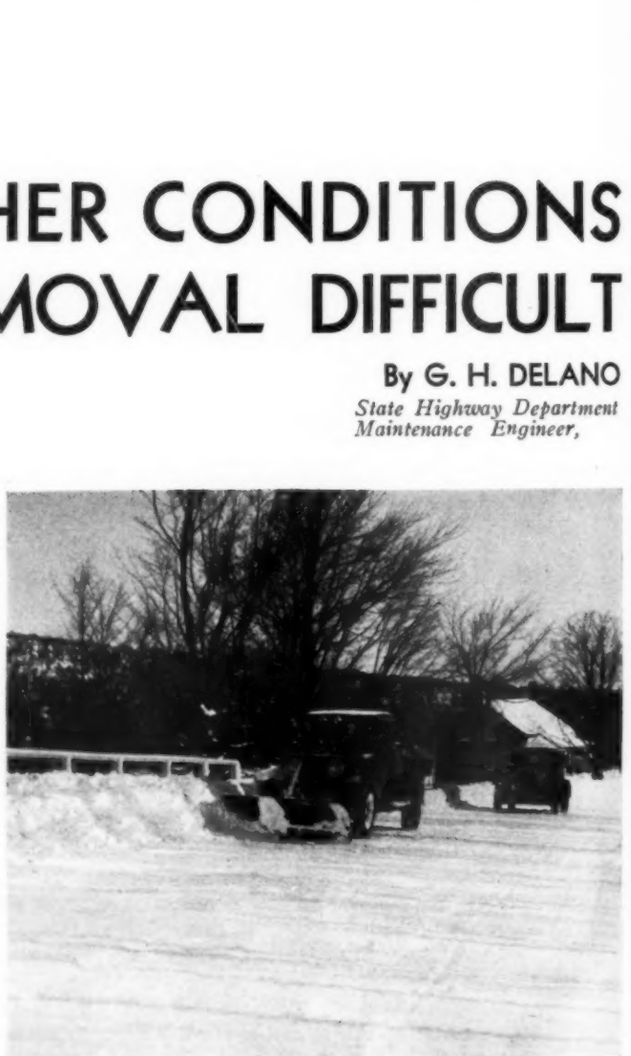
By G. H. DELANO
State Highway Department Maintenance Engineer,

THE winter of 1933 and 1934 was unusually cold and was accompanied by a heavy snow fall. These conditions made snow removal work in the northern states rather a difficult operation. Massachusetts received its share of the cold weather and snow, there being a total snow fall of approximately 62 in.

All the available equipment was used and it became necessary to transfer some of the equipment from what is known as the Cape Cod District to the western section of the state as the snow fall along the shore was not as heavy as that in the interior. In many cases the snow was piled at the side of the road to a height of 6 to 10 ft. by the use of powerful trucks and five and 10-ton tractors.

Snow Fighting.—Our program calls for the constant plowing of highways from the time a storm commences until its finish and the roads are cleared for the full width of the surface. Blade plows on light and medium weight trucks are used to do the general plowing. These trucks work in pairs thus clearing a width to care for two lanes of traffic and prevent traffic from scattering the ridge of snow left by the plows by driving through it. When the ridge at the side of the road becomes large trucks of greater weight and traction are called into service and the ridge is pushed back to provide room for further plowing. This is repeated to allow for the next storm. Trucks and tractors with "V" plows are used to push back the ridges.

Remedying Slippery Conditions.—This constant plowing and the large amount of traffic using the roads cause a film of packed snow and ice to accumulate which is difficult to remove and creates a very slippery condition. This condition is cared for by sanding. Calcium chloride is mixed with the sand in order to make the sand stay in place and also to assist in melting the snow the sooner to clear the highways to the surface.



Light Truck with an 8-ft. Plow Doing Patrol Work in Town of Westminster.

The cold weather made the removal of the film of snow and ice much more difficult than it has been in ordinary years. Our highways were covered with this film for long periods and was the cause of a great deal of extra sanding.

The sanding is done almost entirely by mechanical

"V" Plow Pushing Back Ridge of Snow by the Side of Road Left by the Patrol Trucks. This Is a Procedure Followed After Each Storm. The Picture Was Taken Feb. 23, 1934, in Town of Northboro.

spreaders attached to the rear of trucks which saves sand as well as time and labor; but in spite of this the cost of sanding our highways during the past winter was considerably more than the cost of plowing. This can be readily understood when it is realized that the plowing is done but once, that is, during the storm and only a short period following. The sanding due to cold weather with some melting and freezing in the middle of the day would require sanding almost daily.

Use of Light Trucks.—This year saw the introduction on a large scale of the 8-ft. plows mounted on light trucks. This equipment was found to be very satisfactory when not given too large an area to plow and when the snow was not too deep. We have constructed in the past few years many grade separations, the two roadways being connected by ramps. This light equipment was found to be especially useful in clearing these ramps, leaving the patrol units to work without interruption on the through roads.

Truck Equipped with Sand Spreader Covering Slippery Surface with Sand.

Equipment and Materials.—The following equipment was in operation during the past season:

25 trucks with "V" plows
23 tractors with "V" plows
106 trucks with blade and one-way plows
111 1½ ton trucks with 8-ft. blade plows
138 sand spreaders
400 hired trucks (average)

In the winter of 1932 and 1933 approximately 48,000 cu. yds. of sand and 1,822 tons of calcium chloride were used for sanding the highways. The amount used during 1933 and 1934 is not available at this time as our year does not end until Nov. 30 but it is estimated that there is an increase in the amount used during the past winter of approximately 50 per cent.

The number of miles of state highway plowed was 1,642.

▼

An Investigation of Snow Drifting

Studies of the effect of various types of barriers on snow drifting have been made at the Michigan Engineering Experiment Station at East Lansing, Mich. Flake mica of a density of 0.2 and 0.22 and fine balsam sawdust, density 0.03 to 0.15 were used in place of snow. While the flake mica was heavier than most drifting snows, it seemed to serve the purpose very well and was used in most of the tests. The lighter material was used to determine the effect produced by change in density. The investigation was made with a wind tunnel having a test section 2 ft. square and 10 ft. long. The floor of the tunnel was coarse sandpaper, and the interior could be lighted for observation and taking pictures. Model snow plows of various types were built to a scale of 1 in. equals 2 ft. A range of 2 ft. to 10 ft. in height was covered and the fences were long enough to reach from side to side of the tunnel. The tests were run at an average velocity of 15 miles per hour.

While the results of the tests should be considered as relative, they compare favorably with the results obtained by the State Highway Department of Michigan with snow fences on highways. A partial summary of the results, taken from a Bulletin by E. A. Finney issued last May by the Michigan Engineering Experiment Station follows:

Each type of snow fence produces a characteristic eddy which remains constant for any wind velocity and height of barrier. The end of the eddy varies with the height of fence by the ratio of about 15 to 1 for the horizontal and vertical slat fences and about 10 to 1 respectively for the solid fence.

The size and shape of the eddy controls the size and shape of the completed snow drift.

The ratio of slat width to opening for best results was around 1 to 1 respectively, or 50 per cent open.

Any inclination of the fence from the vertical reduced the length of the eddy and the drift. However, a slight inclination with the wind tends to keep the bottom of the fence clear.

Raising the bottom of the fence more than 12 in. above the ground reduced the effectiveness of the fence at high wind velocities. Six inches above the ground gave the best results.

For a cut section the ratio of depth of cut to end of drift is about 1 to 6 respectively for deep cuts and 1 to 10 for shallow cuts.

Effective snow control could be accomplished, in many instances, by clearing all drift producing elements from the right-of-way areas.

TREATMENT OF ICY PAVEMENTS

THE approach of the season of the year when we may expect icy conditions to develop at intervals on highways and city streets brings to the mind of the highway engineer the necessity for some effective means to combat this grave traffic hazard. Numerous accidents, many of which are fatal, have in the past been attributed directly to lack of traction due to ice on roadways. Of lesser importance than the protection of human life but also a matter of vital concern to the official charged with highway safety has been the property losses from collisions and the loss of time to the public occasioned by the necessity for slower progress on slippery roads.

In connection with this problem, the recently published report of the Maintenance Committee of the Highway Research Board on "The Treatment of Icy Pavements" is most timely. The findings of this committee were adopted at a recent meeting of the American Society for Testing Materials and are accepted as a standard of that organization in treatment of icy pavements. The report shows a 3-year study by the committee which has involved not only field observations but extensive research in the laboratories of the Michigan State Highway Department and the Engineer Department of the District of Columbia.

The research included a study of the use of calcium chloride and sodium chloride in combination with abrasives such as sand as a means of increasing tractive resistance. The presence of the chemicals creates sufficient thawing of the surface of the ice to readily embed the abrasive particles. The investigation also covers the relative melting power of these two salts and their effect on cement concrete surfaces when subjected to repeated freezings and thawings.

The Committee Report reads in part as follows:

"After careful consideration of the results of these investigations, the Committee makes the following recommendations:

"*Use.*—If the treatment is to be applied to cement concrete pavements, the use of calcium chloride is recommended.

"In the case of pavements other than cement concrete the Committee has had no information that either calcium or sodium chloride will promote disintegration by freezing and thawing and therefore either of the chemicals may be used, excepting that calcium chloride is preferable at temperatures lower than 6.5° F. below zero.

"*Abrasive Materials.*—Cinders are preferable, although coarse sand may be used since it is more generally available.

"*Preparation of Stock Piles.*—In treating stock piles to prevent freezing, 25 to 50 pounds of calcium chloride or sodium chloride for each cubic yard of abrasive should be spread over the piles either dry or in solution.

"*Application.*—At the time of application, the material should be treated with an additional fifty pounds of flake calcium chloride or sodium chloride per cubic yard. The treated abrasive should be applied at the rate of 1½ to 2 pounds per square yard of pavement surface. Mechanical spreading is preferable to hand work.

"The use of either chemical, without abrasive, for the purpose of removing ice is not recommended for general practice, excepting in cities where abrasives tend to clog drainage systems. In such cases it is desirable to remove the resulting slush from the pavement.

"There is definite information that the presence of sand or cinders on the pavement surface, after the ice has melted, will cause damage to the pavement by grinding action under the wheels of vehicles. It is therefore important not to apply an excess of sand or cinders and to remove any accumulations of such abrasives from the bottoms of grades or other locations where they may collect." . . .

Conclusions.—"The relative ice-melting power of the two chlorides constitutes a measure of their ability to embed sand. In these tests sodium chloride had the greater melting power and therefore the greater potential sand embedment property at temperatures above approximately plus 10°F. Between plus 10°F. and minus 6.5°F. the differences in melting power are slight. Below minus 6.5°F., approximately the eutectic point of sodium chloride, this salt has no melting or sand embedment power, whereas calcium chloride continues to be active down to its eutectic point, minus 58.5° F....

"Disintegration of concrete which may occur in connection with the treatment of icy pavements with chlorides, is not due to the action of the chlorides, but rather to the repeated freezing and thawing action produced by the treatment.

"Both sodium and calcium chloride, applied to the surface of concrete, increase the pitting and scaling which may occur from repeated freezing and thawing. The use of sodium chloride is more detrimental than the use of calcium chloride. . . .

"One of the most important factors controlling the severity of pitting and scaling is the amount of chert, shale, or soft stone that exists near the surface of the concrete. It is evident from a detailed study of the specimens that the presence of such material near the surface would almost invariably result in deep pitting and removal of surface mortar.

"It should be noted that the results from these tests were due to 30 cycles of freezing and thawing and the solutions of chlorides were the maximum amount which might be used. In practice, a considerable amount of the chloride would be absorbed or absorbed by the abrasive and much of it would be dissipated by traffic. Such results as are shown by these tests would be found only where concentrations of the solutions and abrasives were permitted to remain on the surface of the concrete and where conditions were such that repeated freezing and thawing would occur. The tests do indicate, however, the importance of the proper supervision and care which should be exercised in using this method of treatment of icy pavements.

"Field observations of concrete pavements indicate that:

"There are comparatively few cases where pavement scaling can be attributed to the use of calcium chloride in the treatment of ice.

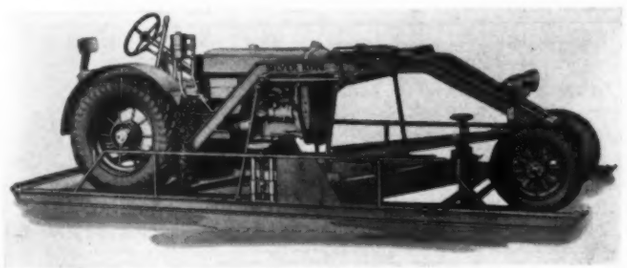
"Many pavements where calcium chloride has been used over a period of years in the treatment of ice, show no indications of scaling.

"The Committee believes that the importance of safeguarding life and property on icy pavements far outweighs the minor damage that may be done to the pavements."

NEW EQUIPMENT AND MATERIALS

New Tractor Powered Road Shaper

A new road shaper powered by a tractor has been brought out by the Fate-Root-Heath Co., Plymouth, O. The design of the shaper enables the operator to set the blades on the machine in connection with the sliding shoe, cutting only the high points and filling that material into the low places. One of the claims made for the machine is that it will not cut nor stir up any material which lies below the level of the road. The shaper has two blades set at opposing angles, thus providing a shearing action from two directions which removes corrugations and irregularities. The material moves slowly along the front blade to a gate, then back along the rear blade, being pulverized and mixed in the process. As the shaper passes over ruts and depressions they are filled by the surplus material. When blades are properly adjust about ⅓ cu. yd. of material is carried in front of the blades at all times. The only escape for the material is underneath the cutting edges. This prevents the formation of drifts or ridges when the road is worked. The blades have double edges and two sets of holes, making them reversible and giving double wear. The blades are also interchangeable. The effective working width of the shaper is 7 ft. By the use of a special apron attachment, the deposit of earth may be narrowed as desired in forming berms and similar work.



The Silver King Road Shaper

The shaper is raised by hand hydraulic lift, and automatically lowered when in neutral position. Blades can be quickly and easily raised and lowered while the machine is in motion.

The straight-edges are 15 ft. in length, rigid and sturdy, and each is provided with wearing shoes ½ in. thick, turned up at each end, and can easily be replaced at low cost when necessary. The cutting edges are attached rigidly to the left-hand straight edge but hinged at the center of the right-hand straight edge. This permits the right-hand straight edge to ride the uneven surface over which it travels, while forming a bridge to support the blades. Screw adjustments are provided to compensate the wear and keep blades cutting at the desired depth.

The shaper is powered by a Silver King tractor manufactured by The Fate-Root-Heath Co., Plymouth, O. The shaper application is easily detached from the tractor, thus making the later available for other work. The four-speed transmission provides variable speeds. The high gear is for transportation or traveling from and to the job, or from one job to another.

▼

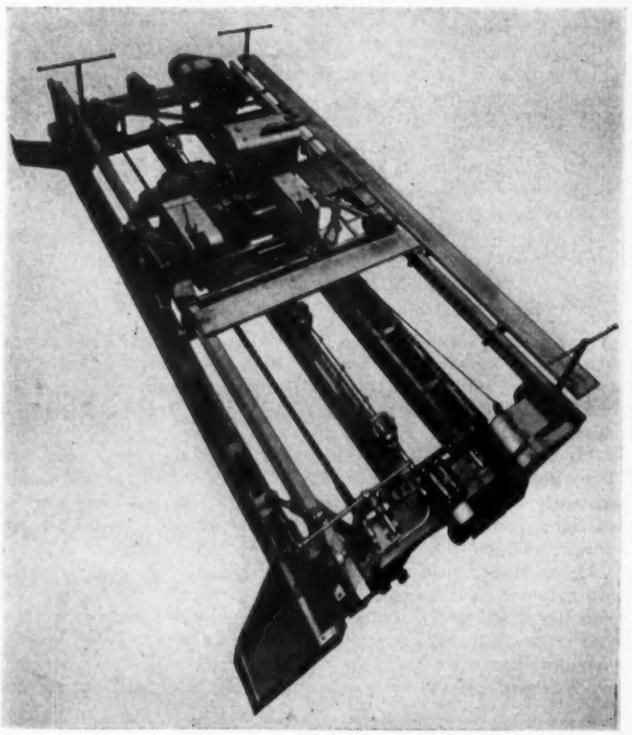
Road Finishing Machine with Surface Vibrator

The illustration shows a Blaw-Knox gas-electric road finisher of 20 ft. width equipped with a surface vibrator for concrete pavement construction. This machine is also equipped with the usual double screed.

The vibrator attachment consists of two independent 10-ft. units, each operated with an independent motor drive. Each of the vibrators is equipped with two vibrating elements, making a total of four. All controls are located at the center of the machine for the convenience of the operator.

The front screed of the finisher is arranged for striking off the concrete at a variable adjustable height above the top of the side forms in order to provide the required excess of concrete to be compacted by vibration.

With the first trip, the concrete is struck off with the front screed and simultaneously vibrated down to the level of the top of the form. The pavement is then double-screeded in the conventional manner.



Blaw-Knox Gas-Electric Roads Finisher with Vibrator Attachment.

One operator controls the entire vibrating and finishing process with no delay to production.

This surface vibrator has the following features:

1. The vibrating member is supported entirely on the surface of the concrete slab; it does not touch the side forms. This eliminates danger of settling or tipping of the forms.
2. The complete vibration unit is spring-suspended from the finishing machine. Vibration is not transmitted into the machine, all of the vibration being absorbed by the concrete.
3. The frequency and amplitude of vibration is adjustable over a wide range to suit varying concrete mixes.

This surface vibrator attachment is furnished in any width required, and to operate below the top of the side forms where necessary.

▼

New, Compact, Lightweight Compressor

Schramm Inc. of West Chester, Pa., has announced the addition of a new compact, lightweight compressor to be known as the "Utility" type to their line of single and two stage portable compressors.

Built in two sizes, these outfits are mounted on two wheel pneumatic tired trailer, either with or without springs. One man can easily handle the compressor on the job. He can pull it from place to place on short hauls. It can quickly be coupled with motor car or truck and transported at speeds up to 35 m.p.h. A trailer type of coupling is provided on the compressor drawbar,

Schramm No. 25 Utility Compressor Coupled to Motor Car.

which provides a flexible connection, adaptable to sharp turns and rough roads.

These "Utility" compressors are complete plants, with air receiver, radiator cooling system, automatic unloading control, and are protected with steel hood with side doors that can be padlocked. Drop leg supports serve to stabilize the compressor when it is in operation. These supports can be swung out of position and locked when the machine is in transit.

The two sizes available are the Model 25 (18 cu. ft. actual air delivery) and the Model 55 (38 cu. ft. actual air delivery).

Bulletin 3403-(RS) will be sent to anyone desiring further information, by writing to Schramm, Inc., West Chester, Pa.

▼

New Hydraulically Controlled Motor Roller

The Huber Manufacturing Co., Marion, O., has just announced a new and improved six cylinder, three speed, hydraulically controlled road roller, which offers many new features.

Power is furnished by an industrial type six cylinder engine developing 59 h.p. at 1200 r.p.m.

Of unusual interest is the new dual steering control which provides a quick, effortless hydraulic power steer that can be changed instantly to the dependable hand steer so desirable in working in tight quarters where the hand steer acts as a vernier to the power steer.

Other Huber road roller features including (1) a dry removable cylinder sleeve application through which water cannot leak into the crank case, making cylinder bore replacement exact, easy and economical; (2) precision engine bearings make it unnecessary to remove engine from chassis to replace bearings which fit crank shaft exactly without scraping or otherwise fitting; (3)

New Huber Hydraulically Controlled Motor Roller

self-adjusting forward and reverse clutches; (4) low pressure hydraulic system; (5) full jeweled with roller bearings . . . twenty-five roller and ball bearings carry every journal including front and rear axles and king pin; (6) differential lock from operator's platform; (7) through going rear axle with direct drive on each roll; (8) low pivot front roll arch makes rolling a straight line over rough ground an easy matter; (9) short turning due to front arch construction; (10) solid hub, web type rolls with spoke web near edge to prevent cracking or breaking of rim; (11) low center of gravity . . . more than three quarters of engine and transmission weight below center of rear axle; (12) narrow rolling width . . . with 20-in. rear rolls, the Huber is only 6 ft. wide; (13) three speeds in both directions ranging from approximately ¾ to 6 m.p.h. through governor control and (14) instantaneous forward or reverse without shifting gears.

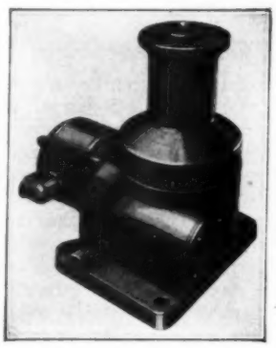
▼

New Prospecting Drills

Bucyrus-Erie Company of South Milwaukee, Wis., announces the introduction of their new Model 26-P and Model 33-P prospecting drills. Either model is equipped with a 20 h.p., 4-cylinder, heavy duty gasoline or a 25 h.p. oil engine, with power-take-off shaft mounted in ball bearings. The Model 26-P has caterpillar type mounting while the model 33-P has steel wheel mounting and both models are furnished with telescopic derrick for convenience in moving. If interested Bucyrus-Erie Company will gladly send a catalog describing and illustrating these new prospecting drills.

Link-Belt Motorized Car Spotter Announced

In line with the trend of the times to design machinery more compactly, Link-Belt Co., Chicago, announces that its vertical Capstan Electric Car Spotter will hereafter be furnished "motorized," meaning that the motor will be attached direct to side of spotter housing, with the result that no motor shaft coupling or separate motor base plate will be required. With motor bolted to side of spotter housing, proper initial and permanent alignment of motor shaft is assured; and the plan measurements of foundation required are a minimum.



Link-Belt Motorized Car Spotter

The motor shaft extends into a substantial one-piece housing, which contains all gears—a helical-gear reduction at motor, and a worm-gear set. The gears run in oil, and are readily accessible. The motor is of high-torque fully enclosed type, and can be removed as a unit complete with motor pinion, without disturbing the rest of the machine. The capstan is machine finished to prolong the life of the car haulage rope.

The Link-Belt Motorized Spotter, like its predecessor, is available in two sizes. The smaller machine has a rope pull of 5,000 lb., and the larger size, 10,000 lb. An eight-page illustrated book No. 1392 covers this new product and will be sent to anyone requesting a copy of it on business letterhead.

▼

Pneumatic Tires for Wheelbarrows

One of the newest and most novel uses for pneumatic tires is reported by The B. F. Goodrich Co., Akron, O., in announcing one of its latest products, the single tube wheelbarrow tire.

Goodrich engineers say that many contractors throughout the country are using only wheelbarrows equipped with pneumatitc tires in their work on roofing jobs. The cushioned wheelbarrow is able to haul its loads without the risk of damage to the roof present when barrows with the older type wheels are used. It is also valuable in hauling loads over sod or soft ground, requiring no planking.

Other types of service in which the wheelbarrow tire has been found extremely valuable are on golf courses, large estates, cemeteries, coal haulage over lawns which a pneumatic tired barrow will not cut up, and in potteries, where breakage is considerably reduced.

The new Goodrich single tube pneumatic tire for wheelbarrows is similar to a bicycle tire in that no inner tube is required. It is therefore much easier to apply and service.

▼

New Heavy Duty Air Cleaner

An oil bath type air cleaner, known as the AC Triplex heavy duty air cleaner, has been introduced by AC Spark Plug Co., Flint, Mich. It is recommended by car manufacturers for use on engines in extremely dusty territories.

It is quickly interchangeable with the silencer and air cleaner installed on the carburetor as standard equipment and will not affect the power and economy in any way. It is designed especially for direct attachment to down-draft carburetors on passenger car engines or trucks equipped with the same engines as used in passenger cars of the same make. In truck service, particularly on construction work, and for passenger cars and trucks used in alkali or extremely dusty territory this AC Triplex cleaner is claimed to be very necessary for prolonging engine life and saving repair expense.

AC Triplex Heavy Duty Air Cleaner

Cleaning operation is simple. Remove the top cover and lift

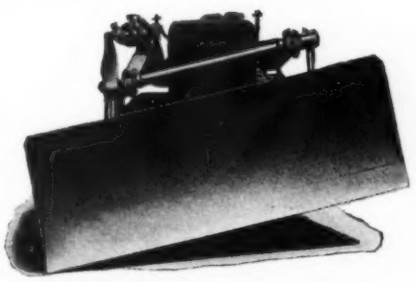
Continental Line

The line of Continental equipment, designed for hydraulic operation with crawler-type tractors, includes Bulldozers, Trailbuilders, Rippers, Pick-Up-and-Carry Scrapers and Snowplows. Write for details.

The Blade Tilts

The blade is hydraulically powered—up and down—or held in any desired position. The operator can tilt the blade as shown below. This makes it possible to grade while the dirt or other material is bulldozed. This is a most desirable feature that speeds up work and reduces equipment outlay.

Continental Bulldozers are built of dynamic steel—developed for equipment subjected to continuous shock.



Something New in Bulldozers

The Continental Bulldozer (Wooldridge Patents) offers the following outstanding features:

1. **Blade can be tilted without the operator leaving the tractor seat.**
2. **Bulldozer is pushed direct from tractor drawbar.**
3. **Can be converted into a Continental Trailbuilder at small cost.**
4. **Snowplow Blade can be attached to bulldozer frame.**
5. **Fabricated primarily from dynamic steel.**

CONTINENTAL ROLL & STEEL FOUNDRY CO.

Industrial Equipment Division

Chicago 332 South Michigan Ave. Illinois

GENERAL OFFICES: EAST CHICAGO, IND.

out the filter element assembly. Wash this in gasoline and allow it to drain thoroughly. Empty the excess oil out of the base and scrape out the accumulated mud. Then wash the entire oil base in gasoline and fill to the indicated level with 1 pint of S. A. E. 50 engine oil.

The periods of cleaning vary greatly according to the particular conditions under which the car or truck is operating. Experience only will tell what this period may be. For very extreme conditions, such as road construction work, etc., once a day is sometimes necessary. For other conditions, experience will govern the proper cleaning period.

▼

New Wagon Drill

A recent addition to its extensive line of drilling equipment announced by the Worthington Pump and Machinery Corporation of Harrison, N. J., is the new Rock Master, which has been developed to speed up many classes of drilling that require a lightweight mobile rig. This rig is readily adaptable for down-hole drilling, line drilling, hillside drilling, breast-hole drilling, side-hole drilling and snake-hole drilling. It can be readily moved from place to place and can be taken to any job where a hand drill can be used. It is used extensively for deep-hole drilling up to 20 ft., supplemented by hand-held drills for boulder popping.

The Rock Master is equipped with a quick and effective hole-spotting device; can be furnished with feeds to accommodate a 3 ft., 4 ft. or 6 ft. maximum steel change; is recommended for holes up to 20 ft. depth; and can be readily equipped with a Worthington No. 27, No. 69, No. 80 or No. 521 pneumatic feed drifter . . . in either wet or dry types.

Literature describing the Rock Master in complete detail may be obtained from Worthington.

The Worthington New Wagon Drill

▼

Power Hammer Direct Operated by Gasoline

A hammer for concrete breaking, demolition work, tamping, drilling, etc., operated by gasoline power, has been placed on the market by the Barco Manufacturing Co., 1801 Winnemac Ave., Chicago, Ill. With the exception of a small box for the battery, this hammer is built into a single unit consisting of a single cylinder, air cooled engine, operating on a two-cycle principle, with the gasoline tank attached to the cylinder and with fuel

SAUERMAN
CRESCENT SCRAPERS

Make fast work of moving wet or dry materials, clay, hard-packed gravel, etc.

Three different models, for operation by two-drum hoist, by boom dragline or by tractor.

The most economical tool for cut-and-fill work, digging concrete aggregate, grading, stripping, canal excavation and other long-range dirt-moving.

Sizes: 1/3 to 15 cu. yds.

Handling capacities up to 600 cu. yds. per hour.

Catalog on request.

Sauerman Bros. Inc.
488 S. Clinton St. Chicago

AMERICAN
STEEL
SHEETS
FOR ALL KNOWN USES

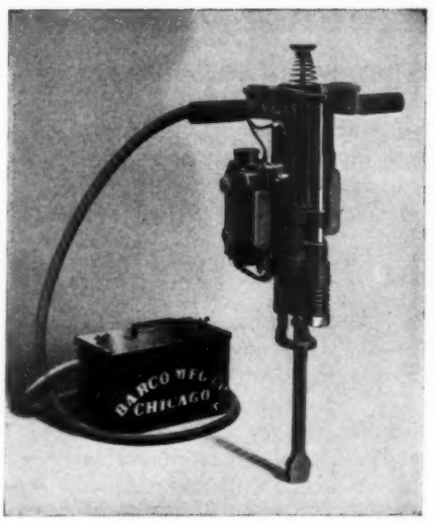
KEYSTONE COPPER STEEL
AMERICAN SHEET AND TIN PLATE COMPANY PITTSBURGH

For Culverts

Use Apollo-Keystone Rust Resisting
COPPER STEEL
Strong, Safe, Durable—Scientifically Produced and Correctly Galvanized

Used by leading culvert and flume manufacturers, because this alloy offers maximum service and satisfaction at right cost. Specify genuine KEYSTONE Quality — and send for literature on actual exposure tests.

AMERICAN SHEET AND TIN PLATE COMPANY, Pittsburgh, Pa.
SUBSIDIARY of UNITED STATES STEEL CORPORATION



Barco Gasoline Hammer

capacity for two hours of continuous operation. The ignition is supplied to the sparkplug from a 9-volt battery, and a coil is located in the battery box for producing the high tension current. The timer is operated by the stroke of the piston. There is a spring under the piston which holds it in the top of the cylinder when the hammer is not in use, but whose purpose it is to return the piston on the up-stroke. To start the engine a small rod at the top is simply pushed down, thus forcing the piston to the bottom of its stroke. On the return stroke the suction draws a sufficient charge of gasoline and air into the lower cavity.

The second downward push of the piston transfers this charge through a by-pass to the explosion chamber. The second return stroke compresses this fuel mixture, operates the timer, causing the power explosion, and from then on each cycle is completely automatic. The lubrication is supplied by mixing a small amount of high-grade lubricating oil with gasoline (low grade) just as is done with outboard motors. The entire piston is hardened and the lower end, coming in contact with an anvil at the bottom of each stroke, delivers the blow which the anvil transmits to the head of the tool, held in place by a tool guide. Standard chisels, tampers, drills, spades, moil points, which can be purchased on the open market, are used.

The heaviest type of the new Barco hammer weighs 89 lb. and can be carried and operated by the average man employed in this kind of work.

▼

Grease Packed in Cartridges Now on the Market

Greases packed in cartridge form to fit a new type of grease gun are now being sold by the Standard Oil Company (Indiana), according to announcement by L. C. Welch, Assistant General Manager. To fill the new type of grease gun the operator merely slips a factory-loaded cartridge into the barrel of the gun which is then ready for use.

The cartridges now being made are of 1-lb. capacity and include several grades of lubricant. This method of handling works equally well with fluid gear lubricant or fairly stiff grease. A partially used cartridge can be quickly replaced with another cartridge of different grade of lubricant, and the lubricant in the used cartridge, being enclosed, is not wasted and does not accumulate dirt.

This new lubrication system has been perfected during the past few years by the Lubrication Corporation, Chicago, a concern owned jointly by the Standard Oil Co. of Indiana and Bendix Aviation Corporation. Each cartridge has a sliding bottom which acts as a plunger to feed the lubricant into the high pressure chamber in the nose of the gun. Cartridges of larger size may be offered in the near future.

Junior Workman Now Equipped with Pneumatic Tires

In order to meet the demand for faster operating speed and quicker moves from one job to another The York Junior Workman, a product of the York Modern Corporation, Unadilla, N. Y., can now be obtained with pneumatic tires as optional equipment. The tires are heavy duty, six ply, size 16x6.50, with extra heavy

Junior Workman Equipped with Pneumatic Tires.

tubes. The Junior Workman combines a rake with a blade unit. The rake teeth are made of special analysis steel, selected for strength, flexibility and wearing ability. They are so spaced that fine material and small stones sift through, thus spreading the good road material, while larger stones are carried to the side of the road. The blade unit consists of three concave blades—one long and two short—bolted to a heavy electrically welded frame. A guide anchored to the main frame holds the blades in position.

WITH THE MANUFACTURERS

Allan Beach Re-Elected Secretary-Treasurer N. I. A. A.

Allan Beach, advertising manager of Littleford Bros., Cincinnati, O., manufacturers of road maintenance equipment, has been re-elected Secretary-Treasurer of the National Industrial Advertisers' Association, which held its annual conference at Cincinnati, O., Sept. 20-22.

Allan Beach

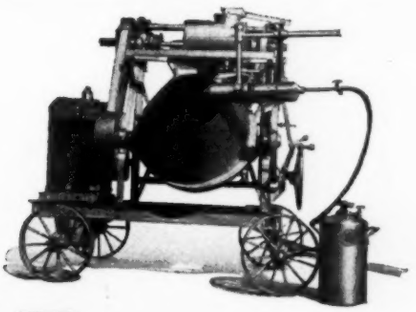
Mr. Beach started in the advertising business about eleven years ago with the Ralph H. Jones Co., a well-known Cincinnati advertising agency, and worked there for five years in the art and production departments.

For the last six years, he has been with Littleford Bros. as advertising manager; and in that capacity prepares all of their trade paper advertising, direct mail literature, sales bulletins and catalogs. His work at Littleford Bros. also includes the editing a house organ known as the Elbee Tatler, which is considered as being one of the most important items in their promotional work, and has done a great deal to build up enthusiasm and good-will among equipment distributors for the company.

In addition to holding the job of secretary-treasurer of the N. I. A. A., he also holds the same job in the Cincinnati Association of Industrial Marketers.

Klinedinst Elected to Timken Board

At a meeting of the Board of Directors of The Timken Roller Bearing Company on Oct. 30, L. M. Klinedinst was elected to the board and also promoted to the office of vice-president in charge of sales to fill the vacancy created by the recent resignation of Judd W. Spray. Mr. Spray plans to



HEAT
for Your Concrete Mixer

Littleford Universal Concrete Heater Units for Tilting and Non-Tilting Drum Mixers will go a long way to help solve your winter heating problems. Whether your mixer has a 3½ or a 28 cubic foot capacity—Littleford has a unit to fit it—*and do a real heating job.* The Universal Attachment can be placed on mixers of any make. *There are no brackets or braces to fool with—no holes to drill.* Write for full particulars. Be sure to tell us the make, type and size of your mixer.

LITTLEFORD BROS.
454 E. Pearl St. Cincinnati, Ohio

BLAW-KNOX BUCKETS

It is a waste of money to handle dead, unnecessary bucket weight on your crane. Blaw-Knox Bucket Engineers can show you how to get the most economical tonnage out of your crane equipment.

Don't hesitate to ask for this valuable advice.

BLAW-KNOX COMPANY · 2003 FARMERS BANK BLDG.
Pittsburgh, Pa. . . . Offices and Representatives in Principal Cities

BLAW-KNOX

REDUCE DIRT MOVING COSTS

THE BLAW-KNOX HYDRAULIC
BULLDOZER

The Blaw-Knox (Ateco) Hydraulic BULLDOZER moves more dirt at less cost. Yardage costs go down. Hydraulic power, two-way control, rigid box type construction. If you are interested in lowering your dirt moving and grading costs, send for Catalog No. 1394.

Complete line of Blaw-Knox Dirt Moving Machinery includes the Blaw-Knox Dirtmover, Sheepsfoot Tamping Rollers, Scarifiers, Clamshell and Dragline Buckets.

Blaw-Knox Company
2003 FARMERS BANK BLDG., PITTSBURGH

BLAW-KNOX

THE HEART OF POWER

• PUMPS FOR ALL PURPOSES

Fig. 909

Roper rotary gear type pumps are made in a variety of sizes, capacities and with maximum mounting flexibility. For pumping lubricating or non-lubricating liquids. Types for general transfer or hydraulic pressure application. The Roper line is complete . . . and flexible.

If YOU want DEPENDABLE pumping service at LOW COST—specify Ropers.

Write today for Bulletin R-5R.

ROPER PUMPS

Dependable *Since 1857*

GEO. D. ROPER CORP., ROCKFORD, ILL.

spend the winter in Florida and rest indefinitely before announcing his future plans.

Mr. Klinedinst has been associated with The Timken Company for 29 years, having started his business career there as a young man immediately upon completing school. During his early years with the company he occupied various junior executive positions in both the manufacturing and selling divisions. Subsequently he was closely identified with automotive development work for many years, serving as assistant sales manager during the period when the company's business was largely confined to automotive applications.

Thirteen years ago, when the company started expanding into the industrial field, he was made general manager of the industrial division, and is largely responsible for the spectacular expansion in the use of Timken Bearings to their present dominant position in nearly every type of industrial equipment. He has been vice president in charge of all industrial sales since 1930.

T. V. Buckwalter, who has been vice-president of The Timken Roller Bearing Company for several years, was elected vice-president and director of The Timken Steel & Tube Company.

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Firm Name Hotchkiss Steel Products Co. Changed

The Hotchkiss Steel Products Co. of Binghamton, N. Y., has announced the complete reorganization and change in firm name to be known in the future as Binghamton Metal Forms, Inc. The same personnel remains intact and they will continue along the same lines of business as previously—the manufacture of road forms, sidewalk, curb and gutter forms, etc.

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Dow Chemical Declares Dividends

At a meeting of the board of directors of The Dow Chemical Company held October 23, 1934, dividends as follows were declared payable Nov. 15 to stockholders of record at the close of business on Nov. 1, 1934; Preferred stock, 1¾%; non par value stock, 50 cts. per share.

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New Loadmaster Distributors for Bucyrus-Erie

Bucyrus-Erie Company of South Milwaukee, Wis., announces the appointment of Irving G. King & Company of Los Angeles, Calif., as loadmaster distributor for the Los Angeles territory. This new distributor is located at 767 Stanford Ave., telephone Vandike 8031. H. A. Stevenson, 7310 Woodward Ave., Detroit, Mich., has been appointed as Loadmaster distributors in the Detroit territory.

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Worth Joins Baldwin Engineering Department

Daniel B. Worth, chief engineer of The Whitcomb Locomotive Company, Rochelle, Ill., has joined the engineering department of The Baldwin Locomotive Works, Philadelphia, where he will be identified with the engineering of Baldwin and Whitcomb electric and internal combustion locomotives. Edward P. Hachtel, Whitcomb production engineering, remains at Rochelle where he will be in charge of inspection and will provide engineering contact with the Whitcomb shops.

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Timken Awarded First Place

It is interesting to readers of ROADS AND STREETS who have seen The Timken Roller Bearing Company advertisements in this publication, to note that that company was awarded first place by the judges for the most effectively conceived and executed industrial advertising campaign of the year in the tool and equipment division of The National Industrial Advertisers Association at the annual convention recently held in Cincinnati.

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Koehring Appoints New Distributors

The Koehring Co., Milwaukee, Wis., announces the appointment of the Cramer Machinery Co., 706 Lewis Bldg., corner South West Fourth and Oak, Portland, Ore., for the sale of Koehring shovels, cranes and draglines, mixers, dumptors and mud-jacks in the State of Oregon, and also the Midland Implement Co., Inc., 2300 Montana Ave., Billings, Mont., for southern Montana.